HEWLETT PACKARD

HP Business Consultant II

HP 19BII
Financial Calculator

Owner's Manual

HP-19B II
Business Consultant II

Owner's Manual

HEWLETT
PACKARD

Edition 3 September 1992
HP Part No. 00019-90054

Notice

For warranty and regulatory information for this calculator, see pages 280 and 283.

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

Printing History

Edition 1	December 1989
Edition 2	February 1991
Edition 3	September 1992

Contents

Part 2: The Solver

Appendices & Index

List of Examples

The following list groups the examples by chapter. The list shows only the longer examples—those that require a moderate number of steps. Shorter examples are included throughout the manual.

Important Information

- To see a demonstration of some of the HP-19B features, turn the calculator on; press ▪ [MODES] (the shifted [DISP] key); press the key directly below the DEMO menu key. Press [ON] to end the demonstration.
- Take the time to read chapter 1. Chapter 1 provides an overview of how the HP-19B works, and introduces terms and concepts that are used throughout the manual. After you've read chapter 1, you will be ready to start using all of the calculator's features, reading other portions of the manual when necessary.
- You can choose either ALG (Algebraic) or RPN (Reverse Polish Notation) calculator operation mode. Throughout the manual the "✓" in the margin indicates that the examples or keystrokes are shown in ALG mode and must be performed differently in RPN. Appendixes D, E, and F explain how to use your calculator in RPN mode.
- Match the problem you need to solve with the calculator's capabilities. There are several ways to locate information about the HP-19B's features: the table of contents, the subject index, and the list of examples.
- As you start learning about menus, use the menu maps in appendix C to see how the HP-19B's menus are organized. After you've become familiar with the HP-19B, the menu maps can help you quickly locate a particular menu.

- The examples that use menus start at the MAIN menu (the menu displayed when you press ▒, then [EXIT]). After you've become familiar with the HP-19B, you probably won't find it necessary to always return to the MAIN menu before beginning a new calculation.
- Before doing any time-value-of-money problems or cash flow problems, learn how the calculator uses positive and negative numbers in financial calculations. For this information, refer to pages 78 and 113.
- To see some examples of Solver equations, browse through chapter 13. There may be several equations you need. In addition, if you are interested in writing your own equations, these examples can help you understand how to use the Solver's features.

Part 1

Fundamentals

1

Getting Started

Watch for this symbol in the margin. It identifies examples or keystrokes that are shown in ALG mode and must be performed differently in RPN mode. Appendixes D, E, and F explain how to use your calculator in RPN mode.

The mode affects only arithmetic calculations — all other operations, including the Solver, work the same in RPN and ALG modes.

Turning the HP-19B On and Off

To turn on the calculator, press [ON]. Pressing [ON] again turns the HP-19B off. Since the HP-19B has *Continuous Memory,* turning it off does not affect the information you've stored. To conserve energy, the HP-19B turns itself off ten minutes after you stop using it.

If you see the low battery symbol (▭) at the top of the display, you should replace the batteries as soon as possible. Follow the instructions starting on page 271.

Setting the Display Contrast

The display brightness and sharpness depend on lighting, your viewing angle, and the display contrast setting. To change the display contrast, hold down [ON] while you press [+] or [-].

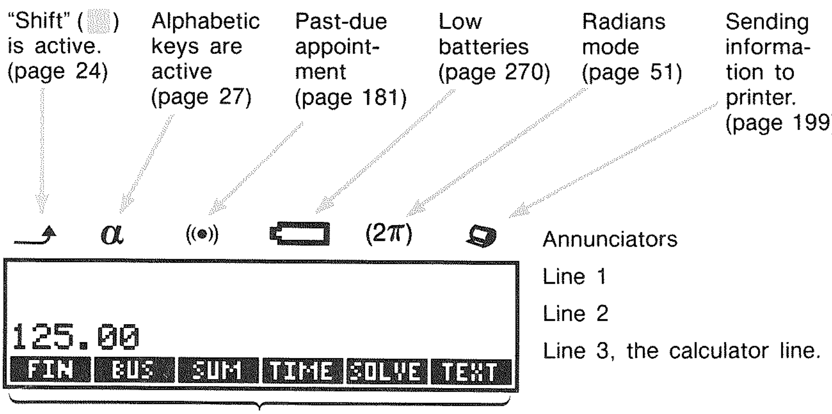
Setting the Language

The calculator can display information in six different languages. The language initially used by the calculator was preset at the factory. To change the language:

1. Press the ▒ key, then [DISP] (also written ▒ [MODES]).
2. Press the blank "menu" key beneath the displayed label "INTL" (also written INTL), which stands for "international."
3. Press the appropriate menu key to change the language.

Using the Display

Key in the simple addition problem 25 + 100 by pressing [2][5][+][1][0][0][=]. Notice how the *cursor* (▒) marks the position where the characters are displayed. When you're done, the display should look like the one below, except that the pictures at the top, called annunciators, won't be on.



Menu labels for the MAIN menu. To display the MAIN menu, press the ▒ key, then [EXIT].

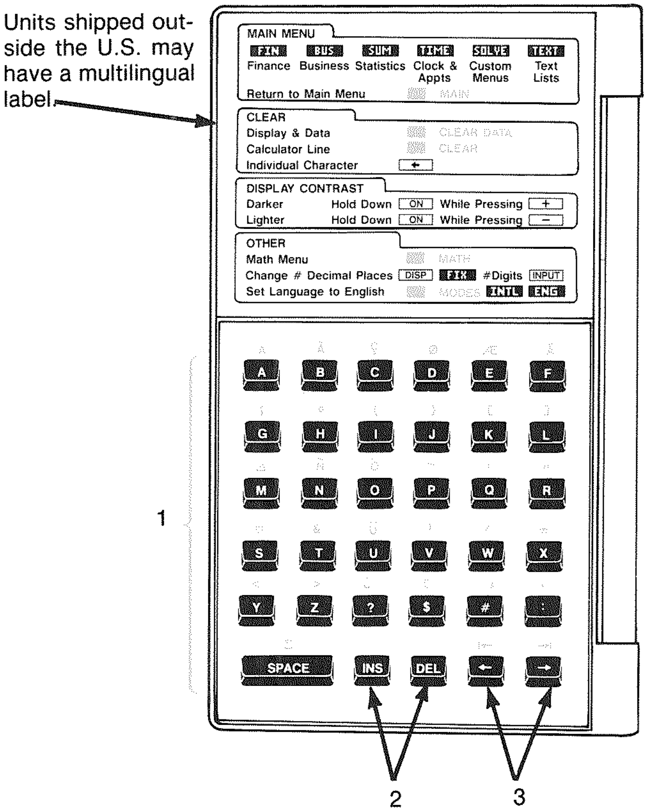
Figure 1-1. The Display

Line 3, the *calculator line*, is used for arithmetic calculations. At times, line 3 is also used as an edit line; information you type is displayed there before some other key enters it into memory.

The contents of lines 1 and 2 depend on the type of calculation you are doing. Sometimes those lines display a history of the previous contents of the calculator line. At other times, lines 1 and 2 display a variety of information, such as results of calculations, lists of numbers, the time and date, and messages.

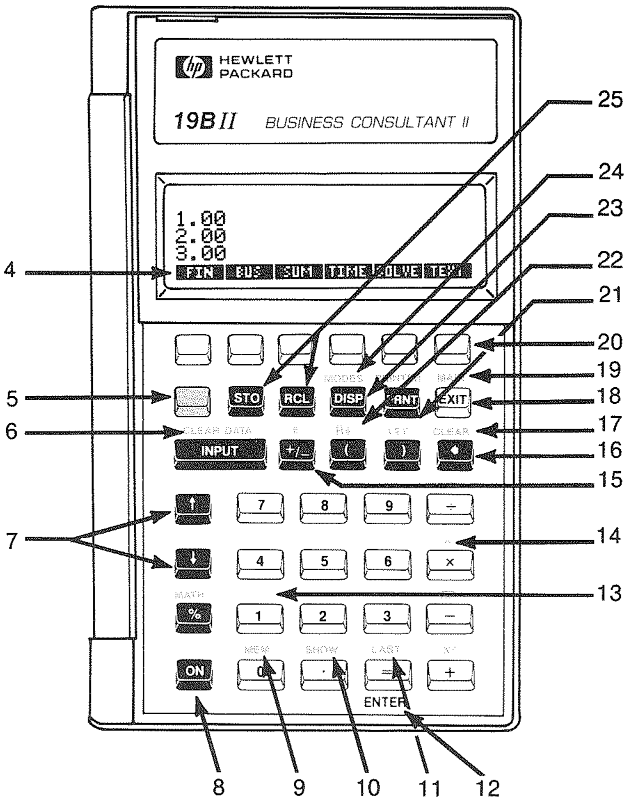
Using the Keyboard

Figure 1-2 illustrates the HP-19B keyboard and briefly describes many of the keys.



1. Alphabetic keys
2. Insert, delete characters
3. Move cursor (when α is on)
4. Menu labels
5. Shift key
6. Clear display and portions of memory
7. Move through lists, history stack
8. ON/OFF
9. Display available memory

Figure 1-2. The Keyboard



10. Show all digits of a number
11. Display previous result
12. [ENTER] (RPN Mode)
13. Access math functions
14. Raise number to a power
15. Change sign
16. Backspace
17. Clear calculator line
18. Display previous menu
19. Display MAIN menu
20. Menu key
21. Exchange RPN registers
22. Roll down RPN stack
23. Change displayed decimal places, decimal point
24. Change language, set modes
25. Store, recall numbers

Figure 1-2. The Keyboard

The Shift ( ) Key

Some of the keys have a second purpose printed above the key. The shift key accesses these operations. To do a "shifted" operation, press and release to turn on the shift annunciator (↗). Then, press the key. For example, pressing followed by [◄] (also written [CLEAR]) clears the calculator line.

If you press by mistake, press again to turn off the shift annunciator.

The [INPUT] Key

The [INPUT] key is used in certain calculations to enter information from the calculator line into calculator memory. Using [INPUT] is covered throughout the manual.

Doing Arithmetic

The " √ " in the margin is a reminder that the example keystrokes are for ALG mode.

Arithmetic is done on line 3—hence the name *calculator line*. This is a brief introduction to the four operator keys—[+], [−], [×], and [÷]. Arithmetic is covered in greater detail in chapter 2.

If you make a typing mistake, use [◄] to backspace to the wrong character.

To add 721.07 and 223.89:

Keys:	Display:	Description:
721.07 [+] 223.89	721.07+223.89	
[=]	944.96	[=] completes the calculation.

Once the HP-19B has completed a calculation, pressing another number key starts a new calculation.

Here are some additional arithmetic problems:

Keys:	Display:	Description:
877.35 [-] 930.89 [=]	-53.54	Subtraction.
65 [×] 12 [=]	780.00	Multiplication.

Negative Numbers

There are two ways to key in negative numbers:

- Key in the number and then press [+/-].
- If the number follows an operator, you can press [-] before keying in the number.

Keys:	Display:	Description:
75 [+/-]	-75	Changes the sign of 75.
[÷] 3 [=]	-25.00	Calculates $-75 \div 3$.
4.52 [×] [-] 7.1 [÷] 12 [=]	-2.67	[-] after [×] changes the sign of 7.1.

Using a Result in Another Calculation

As you've seen, pressing a number key when the calculator line contains a result starts a new calculation. If you press an operator key instead, the HP-19B continues the calculation:

Keys:	Display:	Description:
75 [+] 145 [=]	220.00	Calculates 75 + 145.
[÷] 3.5 [=]	62.86	Divides 220 by 3.5.

The HP-19B lets you do chain calculations (calculations based on the results of previous calculations) without using [=] at the conclusion of each step. Chapter 2 shows you how to do this.

Editing and Clearing the Calculator Line

The cursor is visible when you are in the process of keying in a number or doing a calculation. When the cursor is visible, [◀] deletes the last character you keyed in. When the cursor is not visible, [◀] erases the rightmost number.

To clear the calculator line to 0.00, press [■] [CLEAR].

Keys:	Display:	Description:
12345 [◀][◀] .66	123.66	Edits the calculator line.
[+] 18.95 [=]	142.61	Calculates 123.66 + 18.95.
[■] [CLEAR]	0.00	Clears the calculator line.

The History Stack

Notice how lines 3, 2, and 1 show the results of the current calculation and the two that preceded it. This record of your activities is called the *history stack.*

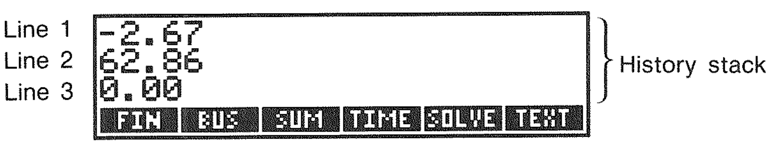


Figure 1-3. The History Stack

Since the HP-19B uses the display for a variety of purposes, sometimes the history stack is replaced by other information. Using the history stack is covered on page 43.

Clearing the Display

Pressing ▒ CLEAR DATA clears the history stack. Sometimes, ▒ CLEAR DATA clears other information. See page 37 for additional information about ▒ CLEAR DATA .

Using the Alphabetic Keys

There are a number of situations where the HP-19B requires you to type alphabetic information into line 3. When line 3 is being used to type in alphabetic information, the alphabetic annunciator (α) comes on and the editing keys described in table 1-1 are active.

Table 1-1. Alphabetic Editing Keys

Key	Description
[◆]	Backspace; erases the character to the left of the cursor.
▒ CLEAR	Clears the calculator line.
[←]	Moves the cursor one character to the left.
▒ [←]	Moves the cursor to the first character on the line.
[→]	Moves the cursor one character to the right.
▒ [→]	Moves the cursor to the end of the line.
[INS]	Inserts one blank space at the cursor position.
[DEL]	Deletes the character at the cursor position.

If you press an alphabetic key when the (α) annunciator is not on, the HP-19B displays:

```
PRESS [EXIT], OR TYPE A
MESSAGE & PRESS [PRNT]
▶
```

If you have the HP 82240 Infrared Printer, you can now print a message (see page 203 for additional information). Otherwise, press [EXIT] to erase the message.

Using the Menu Keys

The six blank keys at the top of the keyboard and six labels on the bottom line of the display are related to one another. The labels tell you what the keys do. The labels are on the display, rather than on the keys themselves, because the keys do different things at different times. The six keys are called *menu keys;* the labels are called *menu labels.*

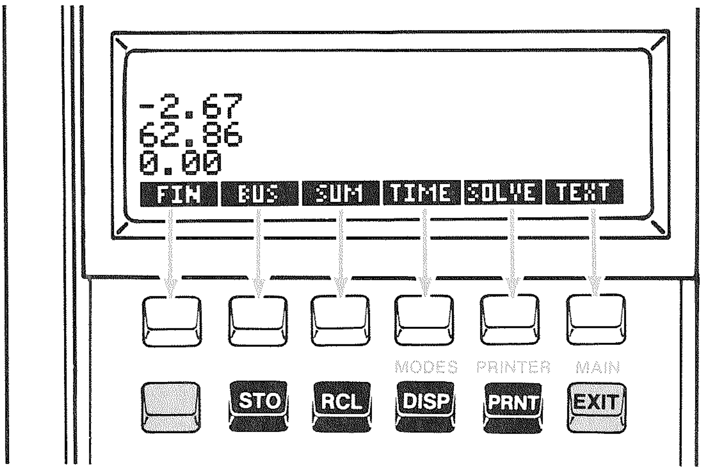


Figure 1-4. Menu Keys and Menu Labels

Depending on what calculations you are doing, the HP-19B displays a particular set of labels, called a *menu.* The menu presents the choices of what you can do next.

The MAIN Menu

No matter which menu you are currently using, pressing [MAIN] displays the MAIN menu. The MAIN menu is the set of primary choices. Starting from the MAIN menu, you can eventually display any other menu. Table 1-2 describes the types of operations done within each major category.

Table 1-2. The MAIN Menu

Menu Key	Operations Done in This Category	Covered in Chapter:
FIN (Finance)	Time-value-of-money (loans, savings, leasing).	4
	Interest conversions.	4
	Cash flows, internal rate of return, net present value.	5
	Bonds, depreciation.	6
BUS (General Business)	Business percentages (percent change, percent of total, markup on cost, markup on price).	3
	Currency exchange.	3
	Unit conversions.	3
SUM	Running totals, subtotals, histograms, statistics, curve fitting, forecasting, plotting *x*,*y*-data.	7
TIME	Clock, calendar, alarms, date arithmetic.	8
SOLVE (Solver)	Creating and using your own menus and variables.	11, 12, 13
TEXT	Storing text information.	9

Changing Menus and Reading Menu Maps

Figure 1-5 is a *menu map* illustrating three menus. The top row is the MAIN menu. Pressing the BUS key displays the BUS (general business) menu. Then, pressing MU%C displays the MU%C (markup as percent of cost) menu. There are no menus that branch from the MU%C menu because the MU%C menu is a final destination—you use it to do calculations, rather than to choose another menu.

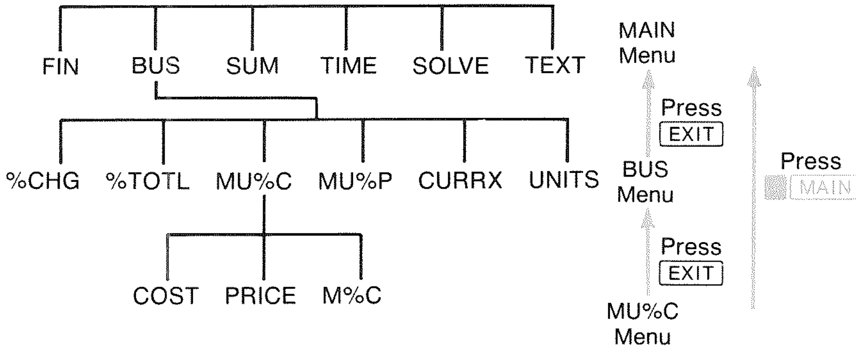


Figure 1-5. A Menu Map

In addition to pressing menu keys, there are two other ways to switch menus:

- Press [EXIT] to return to the previous menu.
- Press [MAIN] to return to the MAIN menu.

When a menu has more than six labels, a menu key labeled MORE is used to switch between sets of labels.

Example: Using Menus. Use figure 1-5 as you follow along in this example. The example calculates the percent markup on cost of a crate of oranges that a grocer buys for $4.10 and sells for $4.60.

Step 1 Decide which menu you want to use. The MU%C (markup as a percent of cost) menu is our destination. If it's not obvious to you which menu you need, look up the topic in the subject index and examine the menu maps in appendix C.

Displaying the MU%C menu:

Step 2 To display the MAIN menu, press [MAIN]. This step isn't always necessary, but it is useful when you want to start from a known location on the menu map.

Step 3 Press BUS to display the BUS menu.

Step 4 Press MU%C to display the MU%C menu.

Using the MU%C **menu:**

Step 5 (Optional)* Press ▒ [CLEAR DATA] to clear the history stack and set the values of *COST*, *PRICE*, and *M%C* to 0.

Step 6 Key in 4.10 and press COST. This stores 4.10 as the *COST*.

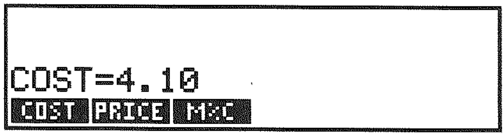


Figure 1-6. Storing the COST

Step 7 Key in 4.60 and press PRICE to store 4.60 as the *PRICE*.

Step 8 Press M%C to calculate the markup as a percent of cost. The answer: MARKUP%C=12.20.

Figure 1-7. Calculating the Markup as a Percent of Cost

Step 9 To leave the MU%C menu, press [EXIT] (to display the BUS menu) or ▒ [MAIN] (to display the MAIN menu).

* This step is optional because *COST*, *PRICE*, and *M%C* are cleared whenever you press BUS to display the BUS menu. However, since you may not always return to the MAIN menu between calculations, you may want to get into the habit of clearing before starting a new calculation.

Doing Calculations Using Menus

Many menus do calculations the same way as the previous markup calculation. You use the menu keys both to store numbers used in the calculations and to do the calculations.

Figure 1-8 illustrates using the MU%C menu to calculate the markup as a percent of cost.

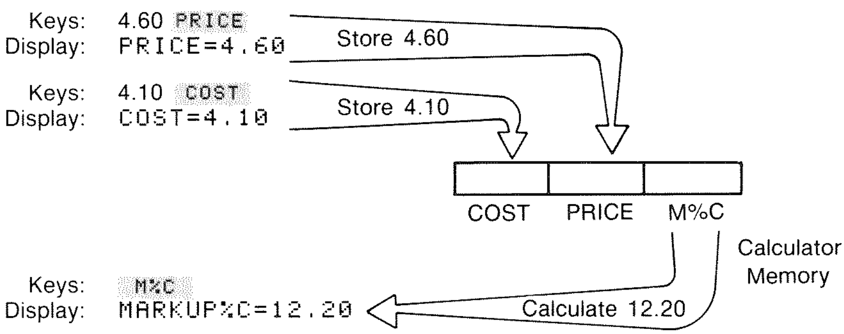


Figure 1-8. Calculating M%C

Figure 1-9 shows another calculation using the MU%C menu. This time, the calculation uses the *COST* and *M%C* to calculate the *PRICE*.

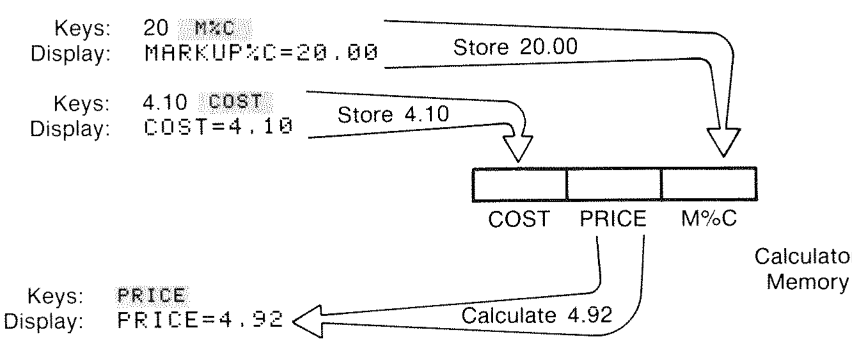


Figure 1-9. Calculating the PRICE

Notice that the two calculations use the same three storage locations; each location is used both to store and to calculate values. These storage locations are called *built-in variables*, because they are permanently built into the HP-19B, and because their contents vary as you store and calculate different numbers.

Rules for Using Menu Variables. The following rules apply to calculations using variables in menus:

- **To store a value**, key in the number and press the menu key.* If you haven't just keyed in a number (for example, you've just switched menus and you want to store the number already in the calculator line), press [STO] followed by the menu key.†
- **To calculate a value**, press the menu key without first keying in a number. In other words, when you press two menu keys one after another, the second key does a calculation. The HP-19B displays CALCULATING... when a value is being calculated.
- **To display a value**, press [RCL] followed by the menu key. For example, [RCL] COST displays the value stored in *COST*.
- **To clear all the variables in a menu**, press ■ [CLEAR DATA] while the menu is displayed. This also clears the history stack. Clearing a menu is useful when you want to start a new calculation without worrying about what numbers may have previously been stored.
- Certain variables can be stored but not calculated, or calculated but not stored. The menu maps in appendix C indicate these variables.

Making a Graceful [EXIT]

The [EXIT] key is used to switch to the previously displayed menu. One particularly important use of [EXIT] is for backing out of a mistake made while switching menus. For example, if you accidently pressed MU%P in the BUS menu when you meant to press MU%C, pressing [EXIT] would return you to the place where you made the mistake—the BUS menu.

* An incomplete arithmetic calculation is completed. For example, 2 [×] 50 COST stores 100 in *COST*.

† If the calculator line contains two or more numbers, [STO] *menu key* stores only the rightmost number into the variable. For example, 2 [×] 50 [STO] COST stores 50 in *COST*.

Creating Your Own Menus and Variables

The MU%C menu is a *built-in* menu; it contains built-in variables, and uses a formula permanently stored in the calculator to calculate answers.

The HP-19B lets you enter your own equations (formulas) into memory, which are then used to create your own menus of variables. Creating and using your own menus is done by the Solver, which is covered in chapters 11, 12, and 13.

The Display Format

When you turn the HP-19B on for the first time, numbers are displayed with two decimal places and with a period as the decimal point. You can change the number of decimal places, and you can also interchange the use of commas and periods in numbers.

Changing the Number of Displayed Decimal Places

To change the number of displayed decimal places:

1. Press [DISP].

```
TO SET #DECIMAL PLACES:
PRESS {FIX} OR {ALL}.
RADIX: {.} OR {,}
 FIX | ALL |  .  |  ,
```

Figure 1-10. The DISP Menu

2. Do **a** or **b**:

   a. To specify the number of displayed decimal places, press **FIX** . Type the number of decimal places (an integer from 0 to 11) and press [INPUT].

   b. To display numbers as precisely as possible (up to a maximum of 12 digits), press **ALL** .

Changing the number of displayed decimal places affects what you see, but doesn't affect internal calculations. Regardless of the number of decimal places displayed, the HP-19B stores all numbers with 12 digits.*

Starting with two displayed decimal places:

Keys:	**Display:**	**Description:**
45 [×] .1256 [=]	5.65	Two decimal places are displayed.
[DISP] FIX 4 [INPUT]	5.6520	Four decimal places are displayed.
[DISP] ALL	5.652	Trailing zeros are dropped.
[DISP] FIX 2 [INPUT]	5.65	Two decimal places are displayed.

Interchanging the Period and Comma in Numbers

To change the decimal point and digit separator, press [DISP]. Specify the decimal point by pressing . or , . . sets a period as the decimal point and comma as the digit separator. For example, the number one million is displayed as 1,000,000.00. , sets a comma as the decimal point and period as the digit separator. For example, one million is displayed as 1.000.000,00.

* An exception is values of PV, PMT, and INT used in amortization calculations (refer to "Amortization" on page 85), which are rounded to the display setting.

During complex internal calculations, the HP-19B uses 15-digit numbers for intermediate results.

Display Messages

Suppose you tried to calculate the markup on cost without storing a value for *COST*. *COST* would have a value of 0, and the calculator would be unable to do the calculation. To help you correct the situation, the HP-19B beeps and displays an error message. The message is erased from the display the next time you press a key. Refer to page 336 for a list of error messages and their possible causes.

The HP-19B frequently displays "help" messages. In these messages, square brackets indicate the labeled keys—for example, [INPUT] and [+]. Curly braces indicate the menu keys—for example, {FIN} and {SOLVE}.

Turning the Beeper On and Off

Ordinarily, the beeper is on, and the calculator sounds an audible tone when error messages are displayed and when appointments come due. However, the HP-19B has three beeper modes for controlling when the beeper sounds. To change the beeper mode:

1. Press ▒ [MODES]. A message indicates the current beeper mode:
   - BEEPER: ON. The beeper sounds when an appointment comes due, error messages are displayed, or you press a key that currently has no function.
   - BEEPER: APPTS ONLY. The beeper sounds only when an appointment comes due.
   - BEEPER: OFF. The beeper does not sound.
2. Press BEEP one or more times to select the desired mode.
3. Press [EXIT].

The other keys in the MODES menu control the trigonometric mode (Degrees/Radians; see page 51), the printing-speed mode (see page 200), the language (see page 20), the demo (see page 16), and algebraic and RPN modes (refer to appendix D).

Clearing Information in Calculator Memory

The [CLEAR DATA] key is a powerful clearing feature:

- Pressing [CLEAR DATA] always clears the history stack.
- If the current menu consists of variables (for example, *COST*, *PRICE*, and *M%C* in the MU%C menu, or a menu of variables created using the Solver), those variables are cleared to 0.
- If the HP-19B is displaying a SUM, CFLO, or TEXT list, or the Solver list of equations, [CLEAR DATA] clears the information in the list. Clearing lists is covered further in the chapters covering each type of list.

Available Calculator Memory

The HP-19B lets you store many different types of information in calculator memory. Each piece of information requires a certain amount of storage space.

The HP-19B has approximately 6,600 units, or "bytes," of memory available for your use. [MEM] displays the amount of unused memory. The information is displayed until you release [MEM].

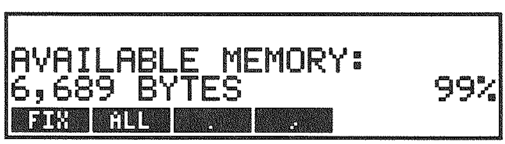


Figure 1-11. Displaying Available Memory

Eventually, you may see the message:

INSUFFICIENT MEMORY

If you encounter this message, you must erase previously stored information before you can store any new information. The amount of memory used by the information you store is covered in "Managing Calculator Memory" on page 274.

In addition to erasing portions of memory, the HP-19B allows you to erase all the information you've stored inside the calculator. This is covered in "Erasing Continuous Memory" on page 276.

2

Arithmetic

If you prefer RPN to algebraic entry logic, please read appendix D before you read this chapter. The " √ " in the margin is a reminder that the example keystrokes are for ALG mode.

Introduction

Chapter 1 introduced you to using the calculator line for simple arithmetic. Chapter 2 contains additional information on doing arithmetic calculations.

Using the Calculator Line

You can use the calculator line (line 3) to do arithmetic calculations at any time, except when the alphabetic annunciator (α) is on. Sometimes the HP-19B displays letters on the calculator line, even though the alphabetic annunciator is off. For example, the calculator line might contain:

TOTAL=124.60

Then, pressing [+] 2 [=] would calculate 124.60 plus 2, and the HP-19B would display the answer, 126.60.

Simple Arithmetic

Here are some examples of simple arithmetic using the keys [+], [−], [×], [÷], and [■][^] ([■][^] raises a number to a power). Notice how the [=] key completes the calculation. You can also use [INPUT] to complete calculations.*

* If the HP-19B is displaying the CFLO or SUM menu, [INPUT] enters the result of the calculation into the list.

Keys:	Display:	Description:
54.69 [+] 28.33 [=]	83.02	
750 [×] 12 [=]	9,000.00	Pressing a number key after [=] starts a new calculation.
1.08 ■ [^] 5 [=]	1.47	Calculates 1.08^5.

Chain Calculations

Chain calculations involve doing more than one operation at a time. Here's one type of chain calculation, based on the previous example:

Keys:	Display:	Description:
750 [×] 12 [=]	9,000.00	Pressing a number key after [=] in the previous example starts a new calculation.

Now see what happens when you press an operator key after [=].

[÷] 360 [=]	25.00	The calculation continues, using the results of the previous calculation.

There's an easier way to do the calculation $\dfrac{750 \times 12}{360}$:

750 [×] 12 [÷]	9,000.00÷	You don't need to press [=]. The HP-19B displays the intermediate answer.
360 [=]	25.00	Press [=] to complete the calculation.

Calculations are done from left to right, in the order they are keyed in. Here's a longer chain calculation.

$$\frac{456 - 75}{18.5} \times \frac{68}{1.509}$$

Watch what happens in the display as you key it in:

456 [−] 75 [÷]	381.00÷
18.5 [×]	20.59×
68 [÷]	1,400.43÷
1.509 [=]	928.05

Percent

In most cases, [%] divides the number furthest to the right by 100. The exception is when a plus or minus sign precedes the number. Then, the [%] key uses the rightmost number as a percent, and calculates that percent of the number preceding the plus or minus sign.

Find 27% of 85.3.

Keys:	Display:	Description:
85.3 [×] 27 [%]	85.30×0.27	Divides 27 by 100.
[=]	23.03	Calculates 27% of 85.3.

Calculate the number that is 10% greater than 25.

25 [+] 10 [%]	25.00+2.50	Calculates 10% of 25.
[=]	27.50	Completes the calculation.

Example: Calculating Simple Interest.* You borrow $1,250 from a relative, and agree to repay the loan in a year with 7% simple interest. How much money will you owe?

Keys:	**Display:**	**Description:**
1250 [+] 7 [%]	`1,250+87.50`	Interest on the loan is $87.50.
[=]	`1,337.50`	You must repay this amount at the end of one year.

Other Keyboard Arithmetic

The other keyboard arithmetic keys are ■ [1/x], ■ [√x], and ■ [x^2]. They act on the number furthest to the right.

Keys:	**Display:**	**Description:**
4 ■ [1/x]	`0.25`	Calculates the reciprocal of 4.
20 ■ [√x]	`4.47`	Calculates $\sqrt{20}$.
[+] 47.2 [×]	`51.67×`	Calculates 4.47 + 47.2.
1.1 ■ [x^2]	`51.67×1.21`	Calculates 1.1^2.
[=]	`62.52`	Completes the calculation.

■ [1/x] is useful for calculating the root of a number:

125^3 ■ [1/x]	`125.00^0.33`	Calculates ⅓.
[=]	`5.00`	Calculates the cube root of 125.

* "Simple Annual Interest" on page 244 describes using the Solver to calculate simple interest.

Using Parentheses in Calculations

Use parentheses when you need to postpone calculating an intermediate result until you've entered more numbers. For example, suppose you want to calculate:

$$\frac{30}{85 - 12} \times 9$$

If you were to key in 30 [÷] 85 [−], the HP-19B would calculate the intermediate result, 0.35. However, that's not what you want. To delay the division until you've subtracted 12, use parentheses:

Keys:	**Display:**	**Description:**
30 [÷] [(] 85 [−]	`30.00÷(85.00-`	No calculation is done.
12 [)]	`30.00÷73.00`	Calculates 85 − 12.
[×] 9	`0.41×9`	Calculates 30 / 73.
[=]	`3.70`	Completes the calculation.

Recalling Numbers to the Calculator Line

Sometimes, you may want to include the result of a previous calculation in a new calculation. There are several ways to reuse numbers.

Using the History Stack

When you start a new operation on the calculator line, the previous contents move to line 2, and eventually, to line 1. Lines 1, 2, and 3 display three lines of the *history stack*—a record of activities.

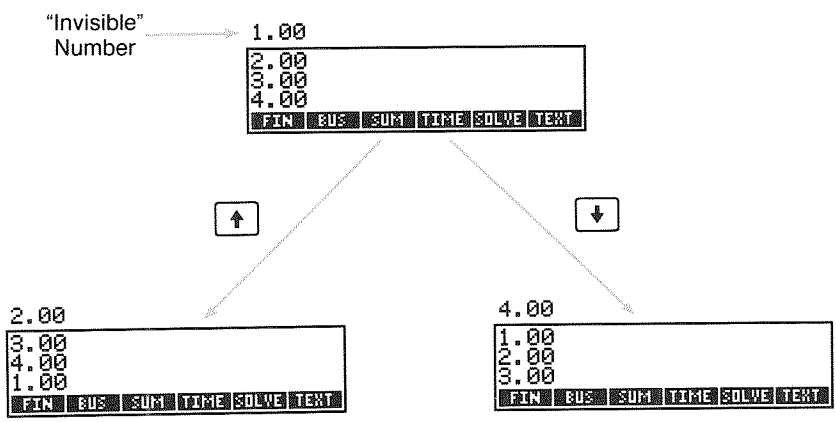


Figure 2-1. The History Stack

The [↓], [↑], and ■ [R↓] keys "roll" the history stack down or up one line. You cannot roll the history stack when there is an incomplete calculation in the calculator line.

The history stack can contain up to four numbers — the three visible numbers and the last number that rolled up off the top of the display. Pressing [↓] brings the number back down. Also, if you hold down [↑] or [↓], you'll see that the history stack wraps around on itself.

Pressing ■ [x≷y] exchanges the contents of the bottom two lines of the display.

The top three numbers in the history stack are automatically cleared whenever you switch menus; the number on the calculator line is retained so that you can use it in other calculations.

Pressing ■ [CLEAR DATA] clears the history stack, and sometimes also clears other information from calculator memory. Refer to page 37 for additional information about ■ [CLEAR DATA].

Keys:	**Display:**	**Description:**
75.55 [−] 32.63		
[=]	42.92	
150 [÷] 7 [=]	21.43	42.92 moves to line 2.

Now, suppose you want to multiply 42.92 × 11. Using the history stack saves you time.

[↓]	42.92	Moves 42.92 back to the calculator line.
[×] 11 [=]	472.12	

The [■] [LAST] Key

[■] [LAST] copies the number in line 2 into a calculation you are in the process of doing.

For example, here is one way to calculate $\dfrac{39 + 8}{\sqrt{123 + 17}}$

Keys:	**Display:**	**Description:**
123 [+] 17 [=]	140.00	Calculates 123 + 17.
[■] [√x]	11.83	Calculates $\sqrt{123 + 17}$.
39 [+] 8 [÷] [■] [LAST]	47.00÷11.83	Copies 11.83 to the calculator line.
[=]	3.97	Completes the calculation.

Using Registers

The HP-19B has 10 registers (storage locations), numbered 0 through 9, that can be used to store and recall numbers.

Storing and Recalling Numbers. To store or recall a number, press [STO] or [RCL], followed by a number in the range 0 through 9.

[STO] copies the number from the calculator line to a designated register. If there is more than one number on the calculator line, [STO] copies only the rightmost number. [RCL] recalls the stored number back to the calculator line.

To cancel the store or recall after you've pressed [STO] or [RCL], press [◀].

The following keystrokes do these two calculations using two registers.

$$\frac{475.6}{39.15} \qquad \frac{560.1 + 475.6}{39.15}$$

Keys:	**Display:**	**Description:**
475.6 [STO] 1	`475.60`	Stores 475.6 into register 1.
[÷] 39.15 [STO] 2	`475.60÷39.15`	Stores 39.15 (the rightmost number) into register 2.
[=]	`12.15`	Completes the calculation 475.60 ÷ 39.15.
560.10 [+] [RCL] 1	`560.10+475.60`	Recalls the contents of register 1.
[÷] [RCL] 2	`1035.70÷39.15`	Recalls the contents of register 2.
[=]	`26.45`	Completes the calculation.

The [STO] and [RCL] keys can also be used with variables. For example, [STO] `M%C` (in the MU%C menu) stores the rightmost number in the calculator line into the variable *M%C*. [RCL] `M%C` copies the contents of *M%C* into the calculator line.

Clearing Registers. In most cases, it is unnecessary to clear registers, since storing a number *replaces* the previous contents. Furthermore, the registers are not used by any of the HP-19B's built-in menus or by the Solver. However, you can clear a single register by storing 0 in it. To clear all the registers, press [STO] [DEL].

Doing Arithmetic Inside Registers. The HP-19B lets you do arithmetic on numbers in registers. The following example stores 45.7 in register 3, multiplies that number by 2.5, and stores the result back in register 3:

Keys:	Display:	Description:
45.7 [STO] 3	45.70	Stores 45.7 into register 3.
2.5 [STO] [×] 3	2.50	Stores 114.25 (45.7 × 2.5) into register 3.
[RCL] 3	114.25	Displays the contents of register 3.

Table 2-1. Arithmetic in Registers

Keys	New Number in Register
[STO] [+]	old number + displayed number
[STO] [−]	old number − displayed number
[STO] [×]	old number × displayed number
[STO] [÷]	old number ÷ displayed number
[STO] [■] [^]	old number ^ displayed number

You can also do arithmetic on numbers stored in variables. For example, 2 [STO] [×] M%C (in the MU%C menu) multiplies the current contents of M%C by 2 and stores the product in M%C.

Scientific Notation

Scientific notation is useful when you are working with very large or very small numbers. For example, the 1984 Gross National Product of the United States was $3,662,800,000,000. Scientific notation writes this number as a smaller number (called a mantissa) times 10 raised to a power. In this case, the decimal point is moved 12 places to the left, and the number is written as 3.6628×10^{12}. The same process is used for very small numbers, except that the decimal point is moved to the right, and 10 is raised to a negative power. For example, 0.00000752 can be written as 7.52×10^{-6}.

When a calculation produces a result too large or too small for the HP-19B to display, the number is automatically displayed in scientific notation, using a capital E in place of "× 10".

To key in numbers in scientific notation:

1. Key in the mantissa. If the mantissa is negative, use [+/-] to change the sign.
2. Press either the alphabetic [E] or ■ [E] to start the exponent.
3. If the exponent is negative, press [-].
4. Key in the exponent.

Keys:	**Display:**	**Description:**
4.78 [E] 13 [÷] 8 [E] 25 [=]	5.98E-13	$4.78 \times 10^{13} \div 8 \times 10^{25}$ equals 5.98×10^{-13}.
2.36 [+/-] ■ [E] [-] 15 [×] 12 [=]	-2.83E-14	$-2.36 \times 10^{-15} \times 12 = -2.83 \times 10^{-14}$.

Showing the Full Precision of a Number

To temporarily view the full 12-digit precision of the number in the calculator line, press ■ and then hold down [SHOW]. Release [SHOW] to restore the calculator line.

Keys:	**Display:**	**Description:**
4.71 [×] 6.02		Number is displayed
[=]	28.35	with two decimal places.
■ [SHOW]	FULL PRECISION IS: 28.3542	Shows the non-zero digits.

The MATH Menu and Trigonometric Modes

A number of other calculator-line math operations are available using the MATH menu, which is displayed by pressing ■ [MATH]. You can display the MATH menu at almost any time, regardless of the menu you are currently viewing. Exiting from the MATH menu displays the menu you were previously viewing.

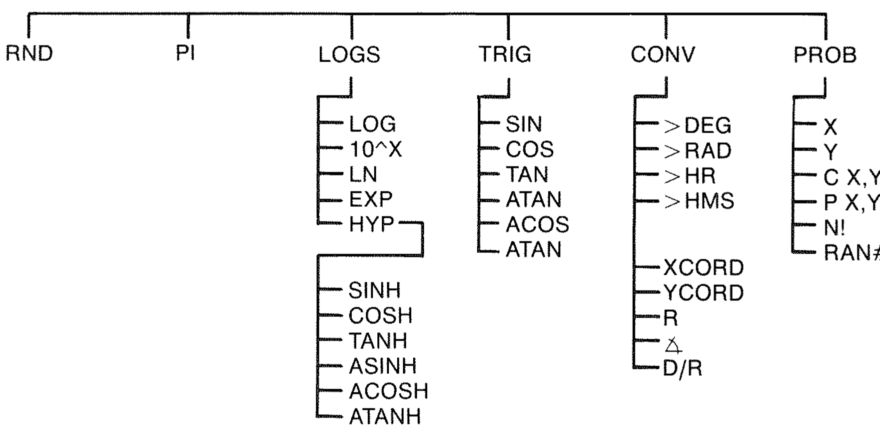


Figure 2-2. MATH Functions

Rounding a Number. RND rounds the number in the calculator line to the number of displayed decimal places. (Before rounding, the stored version of the number may have additional non-zero digits that are not displayed.) Any subsequent calculations using that number use the rounded value.

Keys:	Display:	Description:
4.589 [+] 2.6891 [=]	7.28	Two decimal places displayed.
[SHOW]	FULL PRECISION IS: 7.2781	Displays all stored non-zero digits.
[MATH] RND [EXIT] [SHOW]	FULL PRECISION IS: 7.28	The number has been rounded to two decimal places.

Pi. PI displays the number π (3.14159265359) in the current display format.

Exponential and Logarithmic Functions. Pressing LOGS displays a menu of exponential, logarithmic, and hyberbolic functions.

Table 2-2. Logarithmic Functions

Menu Key	Description
LOG	Common (base 10) logarithm of a positive number.
10^X	Common (base 10) antilogarithm; 10^X.
LN	Natural (base e) logarithm of a positive number.
EXP	Natural antilogarithm; e^X.
HYP	Displays a menu for the hyperbolic functions.
	HYP ↓ ↑ [EXIT]
SINH	Hyperbolic sine.
COSH	Hyperbolic cosine.
TANH	Hyperbolic tangent.
ASINH	Inverse hyperbolic sine.
ACOSH	Inverse hyperbolic cosine.
ATANH	Inverse hyperbolic tangent.

Keys:	Display:	Description:
■ [MATH] LOGS		Displays the LOGS menu.
47.5 LN	3.86	Natural log of 47.5.
HYP 5 SINH	74.20	Hyperbolic sine of 5.
[EXIT] [EXIT] [EXIT]		Exits the MATH menu.

Changing the Trigonometric Mode. The trigonometric functions and polar/rectangular coordinate conversions involve angles that can be interpreted either as degrees or radians, depending on the current trigonometric mode. The (2π) annunciator indicates Radians mode.

To change the trigonometric mode:

1. Press ■ [MODES].
2. Press D/R . Check for the presence or absence of the radians annunciator.
3. Press [EXIT] to return to the menu you were viewing previously.

For ease of use, there is another D/R key in the CONV menu.

Trigonometric Functions. Pressing TRIG displays a menu of trigonometric functions. Angles are interpreted in degrees or radians, depending on the trigonometric mode.

Table 2-3. Trigonometric Functions

Key(s)	Function	Key(s)	Function
SIN	sine	ASIN	arc sine
COS	cosine	ACOS	arc cosine
TAN	tangent	ATAN	arc tangent

Keys:	**Display:**	**Description:**

If the (2π) annunciator is on, press [MODES] D/R to set Degrees mode.

[MATH] TRIG 15 [SIN]	0.26	Sine of 15°.
2.73 ATAN	69.88	Arc tangent of 2.73.
[EXIT] [EXIT]		Exits the MATH menu.

Conversions Involving Angles. Pressing CONV displays the CONV menu, described in table 2-4.

Table 2-4. Conversion Functions

Menu Key	Function
	Angle and Hour Conversions
>DEG	*To degrees*; converts the number from a radian value to its decimal degree equivalent.
>RAD	*To radians*; converts the number from a decimal degree value to its radian equivalent.
>HR	*To hours*; converts the number from hours(degrees)-minutes-seconds-decimal seconds format (H.MMSSss or D.MMSSss) to decimal hours (or degrees) format.
>HMS	*To hours-minutes-seconds*; converts the number from decimal hours (or degrees) to hours(degrees)-minutes-seconds-decimal seconds format (H.MMSSss or D.MMSSss).
	↓ MORE ↑
	Polar/Rectangular Coordinate Conversions
XCORD	Stores the *x*-coordinate or calculates the *x*- and *y*-coordinates.
YCORD	Stores the *y*-coordinate or calculates the *x*- and *y*-coordinates.
R	Stores the radius or calculates the radius and angle.*
∡	Stores the angle or calculates the radius and angle.*
D/R	Switches between Degrees and Radians mode.

* The angle is interpreted as degrees or radians, depending on the current mode.

Keys:	Display:	Description:
[MATH] 1.79		Calculates 1.79π.
[×] PI [=]	5.62	
CONV >DEG	322.20	Converts 1.79π radians to degrees.
90.2015 >HR	90.34	Converts 90 degrees, 20 minutes, 15 seconds to decimal degrees.

Convert the rectangular coordinates (10, −15) to polar coordinates:

MORE		Displays the second page of the CONV menu.

If the (2π) annunciator is on, press D/R to set Degrees mode.

10 XCORD	XCOORD=10.00	Stores the x-coordinate.
15 [+/-] YCORD	YCOORD=-15.00	Stores the y-coordinate.
R	∡=-56.31 RADIUS=18.03	Calculates the radius and angle.
[EXIT] [EXIT]		Exits the MATH menu.

Probability Functions. Pressing PROB displays the PROB menu.

Table 2-5. The PROB Menu

Menu Key	Description
X Y	Stores *x* and *y* for calculating combinations and permutations.
C X,Y	Combinations; calculates the number of different *sets* containing *y* items that can be taken from a larger group of *x* items. Different orders of the same *y* items are not counted separately.
P X,Y	*Permutations*; calculates the number of different *arrangements* of *y* items that can be taken from a larger group of *x* items. Different orders of the same *y* items are counted separately.
N!	Calculates the factorial of the rightmost number on the calculator line.
RAN#	Displays a random number in the range 0 up to (not including) 1.*

* The number is part of a sequence of uniformly distributed pseudo-random numbers. This sequence passes the spectral test (D. Knuth, *Seminumerical Algorithms*, Vol. 2 (London: Addison Wesley, 1981)

When RAN# is pressed for the first time, the HP-19B uses the system clock to generate a *seed*—a number that initiates the sequence of random numbers. Pressing 0 [STO] RAN# uses a new seed from the system clock. To specify a particular seed, key in the seed (a non-zero number) and press [STO] RAN# . You can repeat a random number sequence by storing the same non-zero seed.

Keys:	Display:	Description:
■ [MATH] PROB		Displays the PROB menu.
5 X	X=5.00	Stores *x*.
3 Y	Y=3.00	Stores *y*.
C X,Y	C X,Y=10.00	Calculates combinations.
P X,Y	P X,Y=60.00	Calculates permutations.
[EXIT] [EXIT]		Exits the MATH menu.

Range of Numbers

Figure 2-3 illustrates the range of numbers the HP-19B can store. Underflow displays a warning, followed by 0. Overflow displays a warning and the largest positive or negative number possible.

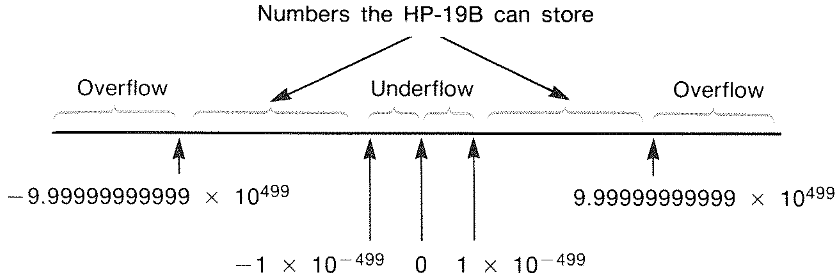


Figure 2-3. Range of Numbers

3

General Business Calculations

Introduction

The BUS (business) menu accesses menus for solving four types of business percentage problems, and for doing currency exchange and unit conversion calculations.

Table 3-1. The BUS Menu

Menu Key	Description
%CHG	*Percent change*; the difference between two numbers, expressed as a percentage of one of the numbers.
%TOTL	*Percent of total*; the portion that one number is of another, expressed as a percentage.
MU%C	*Markup as a percent of cost*; the difference between price and cost, expressed as a percentage of the cost.
MU%P	*Markup as a percent of price*; the difference between price and cost, expressed as a percentage of the price.
CURRX	*Currency exchange*; converting any currency to its equivalent in another currency
UNITS	*Unit conversions*; converting between different units of area, length, mass, temperature, and volume.

Business Percentage Calculations

Each of the four business percentage menus contains three variables. You can calculate any one of the three if you know the other two. To do a calculation:

1. From the MAIN menu, press BUS .
2. Press a menu key to select the appropriate menu.
3. Store each of the values you know by keying in the number and pressing the appropriate menu key.
4. Press the menu key for the value you want to calculate. The answer is displayed in the calculator line.

Percent Change

The %CHG menu consists of three variables—*OLD*, *NEW*, and *%CH*. The percent change (*%CH*) is expressed as a percentage of the *OLD* number.

Example: Calculating the Percent Change. Part 1: Last year, total sales for Dave's Cheese Steaks were $110,000. This year, sales are $115,000. What is the percent change between last year's sales and this year's?

Keys:	**Display:**	**Description:**
BUS %CHG		Displays the %CHG menu.
110000 OLD	OLD=110,000.00	Stores 110,000 in *OLD*.
115000 NEW	NEW=115,000.00	Stores 115,000 in *NEW*.
%CH	%CHANGE=4.55	Calculates the percent change.

Part 2: What would this year's sales have to be to show a 12% increase from last year? (*OLD* remains 110,000, so you don't have to key it in again.)

12 %CH	%CHANGE=12.00	Stores 12 in *%CH*.
NEW	NEW=123,200.00	Calculates the value 12% greater than 110,000.

Percent of Total

The %TOTL menu consists of three variables—*TOTAL*, *PART*, and *%T*.

Example: Calculating the Percent of Total. Part 1: Total assets for Evett Company are $675,840. The firm has inventories of $234,576. What percentage of total assets is inventory?

Keys:	**Display:**	**Description:**
BUS %TOTL		Displays the %TOTL menu.
675840 TOTAL	TOTAL=675,840.00	Stores $675,840 in *TOTAL*.
234576 PART	PART=234,576.00	Stores $234,576 in *PART*.
%T	%TOTAL=34.71	Calculates the percent of total.

Part 2: Last year, Evett Company incurred salary expenses that were 45% of operating expenses. If operating expenses were $76,249, what were salary expenses?

45 %T	%TOTAL=45.00	Stores 45 in *%T*.
76249 TOTAL	TOTAL=76,249.00	Stores 76,249 in *TOTAL*.
PART	PART=34,312.05	Calculates 45% of the total.

Markup on Cost

The MU%C menu consists of three variables—*COST*, *PRICE*, and *M%C*.

Example: Markup on Cost Calculations. The standard markup on blouses at Marcia's Boutique is 60%. The boutique just received a shipment of blouses costing $19.00 each. What is the retail price per blouse?

Keys:	Display:	Description:
BUS MU%C		Displays the MU%C menu.
19 COST	COST=19.00	Stores the cost.
60 M%C	MARKUP%C=60.00	Stores 60% in *M%C*.
PRICE	PRICE=30.40	Calculates the price.

Markup on Price

The MU%P menu consists of three variables—*COST*, *PRICE*, and *M%P*.

Example: Calculating the Markup as a Percent of Price.
Part 1: Megowan's Music purchases guitars for $225, with a discount of 4%. The guitars are sold for $300. What is the markup as a percent of the selling price?

Keys:	Display:	Description:
BUS MU%P		Displays the MU%P menu.
225 [−] 4 [%] COST	COST=216.00	Calculates and stores the net cost.
300 PRICE	PRICE=300.00	Stores 300 in *PRICE*.
M%P	MARKUP%P=28.00	Calculates the markup as a percent of price.

Part 2: What is the markup as percent of price without the 4% discount?

225 COST	COST=225.00	Stores 225 in *COST*.
M%P	MARKUP%P=25.00	Calculates the markup as a percent of price.

Clearing the Business Percentage Variables

Clearing variables sets them equal to 0.

To clear the variables used by any of the business percentage menus, display the menu and press ■ CLEAR DATA. For example, pressing ■ CLEAR DATA while in the %CHG menu clears *OLD*, *NEW*, and *%CH*. Clearing COST or PRICE in the MU%C or MU%P menu clears the value in both menus.

All the business percentage variables are cleared when you exit the BUS menu.

Sharing the Business Percentage Variables Between Menus

If you compare the MU%C menu and the MU%P menus, you'll see that they have two menu labels in common— COST and PRICE :

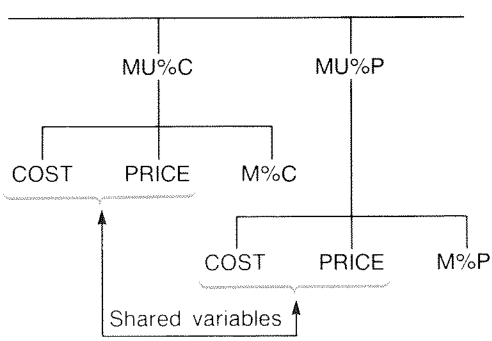


Figure 3-1. Shared Variables

The HP-19B keeps track of the values you key in according to those labels. For example, if you key in a *COST* and *PRICE* in the MU%C menu, exit to the BUS menu, and then display the MU%P menu, the HP-19B retains those values. In other words, the variables are *shared* between the two menus.

Example: Using Shared Variables. Part 1: Fredriksen's Food Cooperative buys cases of canned soup with an invoice cost of $9.60 per case. If Fredriksen's routinely uses a 15% markup on cost, for what price should it sell a case of soup?

Keys:	Display:	Description:
BUS MU%C		Displays the MU%C menu.
9.60 COST	COST=9.60	Stores 9.60 in *COST*.
15 M%C	MARKUP%C=15.00	Stores 15% in *M%C*.
PRICE	PRICE=11.04	Calculates the retail price per case.

Part 2: What is the markup on price?

EXIT MU%P		Exits the MU%C menu and displays the MU%P menu.
M%P	MARKUP%P=13.04	Calculates the markup as a percent of price.

Currency Exchange Calculations

The CURRX menu does currency exchange calculations between two currencies using an exchange rate that you calculate or store.

The CURRX Menu

To display the currency exchange menu from the MAIN menu, press BUS , then CURRX . The *equivalency message* at the top of the display indicates the two current currencies and the exchange rate (*RATE*).

The equivalency message states that:

1 unit of *currency #1* is equivalent to *x.xxxx* unit(s) of *currency #2*

where *x.xxxx* is the current exchange rate (*RATE*) that you've entered. (The first time you display the CURRX menu, the current currencies are U.S. Dollars and Yen; the rate equals 1.0000.)

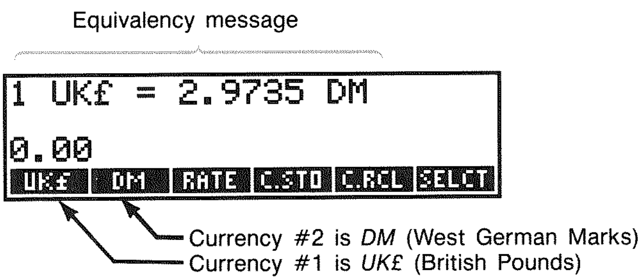


Figure 3-2. The CURRX Menu

Table 3-2 describes the CURRX menu.

Table 3-2. The CURRX Menu

Menu Key	Description
curr1	Current *currency #1*; stores or calculates the number of units of this currency.
curr2	Current *currency #2*; stores or calculates the number of units of this currency.
RATE	Stores or calculates the exchange rate between the two current currencies. The rate is expressed as the number of units of *currency #2* equivalent to 1 unit of *currency #1*.
C.STO	Stores the current *currency #1*, *currency #2*, and *RATE*.
C.RCL	Recalls a previously stored pair of currencies and *RATE*.
SELCT	Selects a new set of currencies.

Selecting a Set of Currencies

To select a pair of currencies:

1. Press SELCT to display the menu of currencies. Press more, if necessary, to see additional currencies (see table 3-3).
2. Press a menu key to select *currency #1*.
3. Press a menu key to select *currency #2*. *RATE* is automatically reset to 1.0000.
4. Enter an exchange rate. There are two ways to enter the *RATE*:
   - *Calculate* the rate from a known equivalency (see the example "Calculating an Exchange Rate," page 65.) Calculating an exchange rate is usually the easier way to enter a correct rate, since the order in which you selected the two currencies doesn't matter.
   - *Store* the exchange rate by keying in the value and pressing RATE (see "Storing an Exchange Rate" on page 66).

Table 3-3. Currencies

US$ U.S. Dollar	CAN$ Canadian Dollar	DM W. German Mark	FF French Franc	UK£ British Pound
BF Belgian Franc	FL Dutch Florin or Guilder	LIT Italian Lira	PTS Spanish Pesetas	SF Swiss Franc
DR Greek Drachma	ESC Portuguese Escudo	IR£ Irish Pound or Punt	S Austrian Schilling	NIS New Israeli Shekel
D.KR Danish Krone	N.KR Norwegian Krone	S.KR Swedish Krona	F.MK Finnish Markka	R Russian Rouble, S. African Rand, Saudi Arabian Riyal
A Argentinean Austral	B Venezuelan Bolivar	CZ$ Brazilian Cruzado	INTI Peruvian Inti	PESO Bolivian, Chilean, Columbian, Mexican, Philippine, and Uruguayan Pesos
HK$ Hong Kong Dollars	NT$ New Taiwan Dollar	RMB Peoples Republic of China Renminbi	WON S. Korean Won	YEN Japanese Yen
$A Australian Dollar	M$ Malaysian Dollar	NZ$ New Zealand Dollar	RP Indonesian Rupiah	S$ Singapore Dollar
BAHT Thai Baht	IN.RS Indian Rupee	PK.RS Pakistani Rupee	CURR1 CURR2 Miscellaneous*	

* Use for currencies not shown in table.

Entering a Rate

The following two examples illustrate the two ways to enter an exchange rate.

Example: Calculating an Exchange Rate. You have just flown from France to Canada, and you need to exchange your French Francs for Canadian Dollars. The conversion chart looks like this:

Canadian Conversion Chart (in CAN$)	
Currency	**Rate**
Britain (*UK£*)	2.1703
France (*FF*)	.2195
United States (*US$*)	1.4015

The chart states these equivalencies:*

1 *UK£*	is equivalent to	2.1703	*CAN$*
1 *FF*	is equivalent to	.2195	*CAN$*
1 *US$*	is equivalent to	1.4015	*CAN$*

Part 1: Select the currencies, and calculate an exchange rate for them.

Keys:	Display:	Description:
BUS CURRX		Displays the CURRX menu.
SELCT FF	CURRENCY 1 IS: FF SELECT CURRENCY 2	Selects *FF* as *currency #1.*

* The chart is in terms of Canadian dollars. Many charts have two columns—a "Buy" column and a "Sell" column. The "Buy" column is used for transactions in which the "bank" buys the listed currency from you in exchange for Canadian dollars. Thus, if you arrive in Canada with *FF*, the exchange rate in the "Buy" column applies for buying *CAN$* with your *FF*. The "Sell" column applies for selling *CAN$* in exchange for *FF*.

CAN$	1 FF = 1.0000 CAN$	Selects *CAN$* as *currency* #2.
1 FF	FF=1.00	Stores number of *FF*.
.2195 CAN$	CAN$=0.22	Stores equivalent number of *CAN$*.
RATE	1 FF = 0.2195 CAN$ RATE=0.22	Calculates the *RATE*.

Part 2: The following keystrokes show that you can reverse the order in which the two currencies are selected.

SELCT CAN$	CURRENCY 1 IS: CAN$ SELECT CURRENCY 2	Selects *CAN$* as *currency 1*.
FF	1 CAN$ = 1.0000 FF	Selects *FF* as *currency* #2; resets rate to 1.0000.
1 FF	FF=1.00	Stores number of *FF*.
.2195 CAN$	CAN$=0.22	Stores equivalent number of *CAN$*.
RATE	1 CAN$ = 4.5558 FF RATE=4.56	Calculates the *RATE* (1 ÷ 0.2195).

Example: Storing an Exchange Rate. If you choose to store the exchange rate directly, you must select the currencies in the correct order, since the *RATE* is defined as the number of units of *currency #2* equivalent to **one** unit of *currency #1*.

Use the Canadian Conversion Chart on page 65 to store an exchange rate for converting between U.S. Dollars and Canadian Dollars.

Keys:	Display:	Description:
BUS CURRX		Displays the CURRX menu.
SELCT US$	CURRENCY 1 IS: US$ SELECT CURRENCY 2	Selects *US$* as *currency #1.*
CAN$	1 US$ = 1.0000 CAN$	Selects *CAN$* as *currency* #2.
1.4015 RATE	1 US$ = 1.4015 CAN$ RATE=1.40	Stores the *RATE.*

Converting Between Two Currencies

Once the currencies are selected and a *RATE* has been entered, you can convert any number of units of one currency to the other.

Example: Converting Between U.S. and Canadian Dollars.
Part 1: Use the exchange rate stored in the previous example to calculate how many Canadian dollars you would receive for 3,000 U.S. Dollars.

Keys:	Display:	Description:
3000 US$	US$=3,000.00	Stores number of *US$.*
CAN$	CAN$=4,204.50	Calculates equivalent *CAN$.*

Part 2: A wool sweater in a shop window costs 75 *CAN$*. What is its cost in U.S. Dollars?

75 CAN$	CAN$=75.00	Stores number of *CAN$.*
US$	US$=53.51	Calculates equivalent *US$.*

Storing and Recalling Sets of Currencies

Pressing C.STO or C.RCL displays the C.STO/CRCL menu, which is used to store and recall sets of currencies and their rates. The menu can store up to six sets of currencies. Initially, the menu contains six blank labels.

Storing Sets of Currencies. To store the current set of currencies and the rate, press C.STO. Then, press any menu key to assign the set to that key. For example, storing the currencies in the previous example stores *currency #1* = *US$*, *currency #2* = *CAN$*, and *RATE* = 1.4015. (The values *CAN$* = 75 and *US$* = 53.51 are not stored.)

Recalling Sets of Currencies. To recall a stored set of currencies and their exchange rate, press C.RCL, followed by the appropriate menu key. The HP-19B automatically returns to the CURRX menu. The equivalency message and menu labels show the recalled currencies and *RATE*.

Clearing the Currency Variables

Pressing ■ [CLEAR DATA] while the CURRX menu is displayed sets the *RATE* to 1.0000. The values of the two current currencies are cleared to 0.

Unit Conversions

The UNITS menu accesses menus for doing unit conversions—for example, converting a given number of kilometers to miles, grams to ounces, or gallons to liters.

Table 3-4 describes the UNITS menu and the unit conversions you can do. Within a particular type of unit (for example, area), you can convert a value to any other unit(s). You can also do mixed unit arithmetic (for example, adding feet plus centimeters).

To convert a number to its equivalent in another unit:

1. From the MAIN menu, press BUS , then UNITS .
2. Select the type of unit; for example, to do length conversions, press LENG .
3. Key in the value and press the menu key corresponding to its unit.
4. Press the menu key for the new unit.

Table 3-4. The UNITS Menu

Menu Key	Description
LENG	*Length*; for converting between: FEET – feet* INCH – inches* M – meters CM – centimeters MM – millimeters MILE – miles* N.MI – nautical miles KM – kilometers YARD – yards* FATH – fathoms ST.MI – U.S. statute miles ROD – rods CHAIN – chains SU.FT – survey feet
AREA	*Area*; for converting between: SQ.YD – square yards* SQ.FT – square feet* SQ.IN – square inches* SQ.M – square meters SQ.CM – square centimeters SQ.MI – square miles* ACRE – acres SQ.RD – square rods SQ.K – square kilometers HA – hectares
VOL	*Volume*; for converting between: GAL – gallons (U.S. liquid) I.GAL – Imperial gallons QUART – quarts (U.S. liquid) PINT – pints (U.S. liquid) LITER – liters CU.YD – cubic yards* CU.FT – cubic feet* CU.IN – cubic inches* CU.M – cubic meters AC.FT – acre-feet CUP – cups TBSP – tablespoons TSP – teaspoons

* Based on the international foot, 0.3048 meters.

Table 3-4. The UNITS Menu (continued)

Menu Key	Description
	Volume (continued) FL.OZ – fluid ounces (U.S.) ML – milliliters BU – bushels PECK – pecks D.GAL – dry gallons BD.FT – board feet BBL – barrel of oil (42 U.S. gallons)
MASS	*Mass*; for converting between: LB – pounds (avoirdupois) OZ – ounces (avoirdupois) KG – kilograms GRAM – grams MG – milligrams TON – short tons L.TON – long tons CWT – short hundredweights L.CWT – long hundredweights T – metric tons SLUG – slugs STONE – stones OZ.T – troy ounces DRAM – drams (avoirdupois) GR – grains (avoirdupois)
TEMP	*Temperature*; for converting between: °F – degrees Fahrenheit °C – degrees Celsius °R – degrees Rankine °K – degrees Kelvin

Example: Unit Conversions. Part 1: Convert 100 miles to kilometers.

Keys:	**Display:**	**Description:**
BUS UNITS		Displays the UNITS menu.
LENG MORE		Selects length units.
100 MILE	MILES=100.00	Stores 100 miles.
KM	KM=160.93	Converts 100 miles to kilometers.

Part 2: How many liters and cubic inches are equivalent to 3 pints?

EXIT VOL		Selects volume units.
3 PINT	PINTS=3.00	Stores 3 pints.
LITER	LITERS=1.42	Converts 3 pints to liters.
MORE CU.IN	CU.IN=86.63	Converts 3 pints to cubic inches.

Arithmetic With Two or More Units

Suppose you wanted to calculate the number of inches and the number of meters in 4 yards + 2 feet + 9 inches. One way to do the calculation is to convert the yards and feet to inches separately, add the results together, add 9 to calculate total inches, and then convert the result to meters. However, the UNITS menu provides an easier way to do calculations involving different units, using storage arithmetic ([STO][+], [STO][−], etc.).

Example: Adding and Subtracting Different Units. Part 1: Calculate the number of decimal feet and the number of meters in 11 feet + 9 inches:

Keys:	Display:	Description:
BUS UNITS LENG		Selects length units.
11 FEET	FEET=11.00	Stores 11 feet.
9 [STO] [+] INCH	9.00	Internally adds 9 inches to 11 feet.
FEET	FEET=11.75	Calculates decimal feet.
M	METERS=3.58	Calculates meters.

Part 2: If you remove 3 quarts of liquid from a full, 5-gallon (U.S. gallons) container, how many quarts remain:

[EXIT] VOL		Selects volume units.
5 GAL	GALLONS=5.00	Stores number of gallons.
3 [STO] [-] QUART	3.00	Subtracts three quarts.
QUART	QUARTS=17.00	Number of quarts remaining.

Knowing how the UNITS menu works helps you understand how the calculator does arithmetic with two or more units. Unit conversions use a *single* storage location and a *base* unit for each type (length, area, etc.) of unit; for example, meters (M) is the base unit of length. When you store a length value, it is automatically converted to meters; when you calculate a value, the conversion is from meters to the new unit (see figure 3-3).

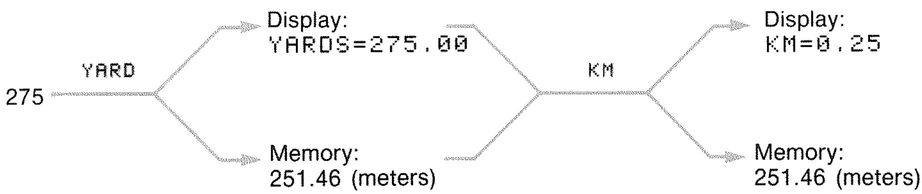


Figure 3-3. How the HP-19B Does Unit Conversions

Similarly, arithmetic with mixed units is done in the base unit (see figure 3-4).

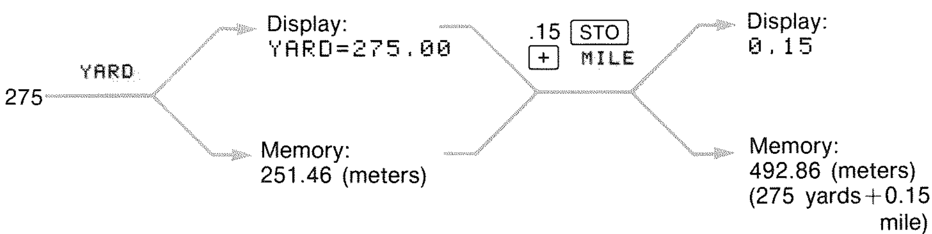


Figure 3-4. How the HP-19B Does Arithmetic With Mixed Units

Clearing the UNITS Variables

Pressing CLEAR DATA while any of the units menus are displayed clears the unit values to 0. The unit values are also cleared whenever you switch menus.

4

Time Value of Money and Interest Conversions

Introduction

The phrase *time value of money* describes calculations based on money earning interest over a period of time. There are two types of interest:

- In *simple interest* calculations, the amount of interest is a percent of the principal and is repaid in a lump sum. For example, if you lend a friend $500.00 for a year and you want to be repaid with 6% simple interest per year, your friend owes you $500 + (6/100 × $500) = $530. See pages 42 and 244 for examples of simple interest calculations.
- *Compound interest* calculations take into account that interest, added to the principal at specified *compounding periods*, also earns interest. Many time value of money problems—for example, savings accounts, mortgages, pension funds, leases, and annuities—are compound interest calculations. Amortization calculations determine the amounts applied toward principal and interest in a payment or series of payments.

The TVM Menu

The time value of money (TVM) menu is used for certain compound interest calculations.* Specifically, use the TVM menu when there is a series of cash flows (money received or money paid) and:

- The dollar amount is the same for each payment.†
- The payments occur at regular intervals.
- Payment periods coincide with the compounding periods.

To display the TVM menu, starting from the MAIN menu, press FIN , then TVM .

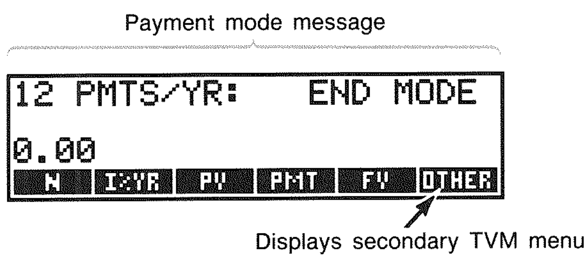


Figure 4-1. The TVM Menu

The primary TVM menu has five menu keys for variables, plus OTHER . The OTHER key displays a secondary menu used to change the payment conditions and to display the amortization (AMRT) menu. The message on the display informs you of the current payment conditions (payment mode).

* When the current language is Deutsch (German), an additional menu is available for calculations using Staffelzinsmethode. Refer to the German language owner's manual (reorder number 00019-90015) for additional information.

† For situations where the amount of the cash flow varies, use the CFLO menu.

Table 4-1. TVM Menu Keys

Menu Key	Description
	The TVM Menu
N	Stores or calculates the total number of payments (or compounding periods). *N* can be expressed in any unit of time—for example, years, months, or days.*
■ N	Multiplies number in display by *P/YR* and stores result in *N*. (If *P/YR* were 12, then 30 ■ N would store 360 in *N*.)
I%YR	Stores or calculates the nominal *annual* interest rate as a percentage.†
PV	Stores or calculates the present value of the series of future cash flows. To a lender or borrower, *PV* is the amount of the loan; to an investor, *PV* is the initial investment. *PV* always occurs at the beginning of the first period.
PMT	Stores or calculates the amount of each periodic payment.The payments are the same amount, and no payments are skipped. Payments can occur at the beginning or end of each period.
FV	Stores or calculates the future value—the amount of the final cash flow, or the compounded value of the series of previous cash flows. *FV* always occurs at the end of the last period.
	OTHER ↓ ↑ EXIT
	The Secondary TVM Menu
P/YR	Stores the number of payments or compounding periods per year.‡ The value must be an integer in the range 1 through 999.
BEG	Sets *Begin mode*; used when payments occur at the beginning of each period.
END	Sets *End mode*; used when payments occur at the end of each period.
AMRT	Displays the AMRT (amortization) menu for calculating amortization schedules.

* When the HP-19B calculates a non-integer *N*, the answer must be interpreted carefully. The built-in formulas used by the HP-19B do not calculate partial period payments. Interpreting a non-integer *N* is covered in the savings account example on page 88. Calculations using a stored non-integer *N* produce mathematically correct results, but the results have no simple useful interpretation. See page 246 for an example that uses the Solver for a loan calculation involving an odd first period.

† See page 94 for a definition of the nominal interest rate.

‡ The number of payment periods per year must equal the number of compounding periods per year. If this is not true, see "Compounding Periods Different From Payment Periods" on page 97. For Canadian mortgages, see pages 101 and 248.

Cash Flow Diagrams and Signs of Numbers

It is helpful to illustrate TVM calculations with *cash flow diagrams.* Cash flow diagrams are time lines divided into equal segments of time called *payment periods* or *compounding periods.* Arrows show the cash flows. Money received is a positive number, and the arrow points up. Money paid out is a negative number, and the arrow points down.

The cash flow diagram for a transaction depends on your point of view. For example a loan is an initial positive cash flow for the borrower, and an initial negative cash flow for the lender.

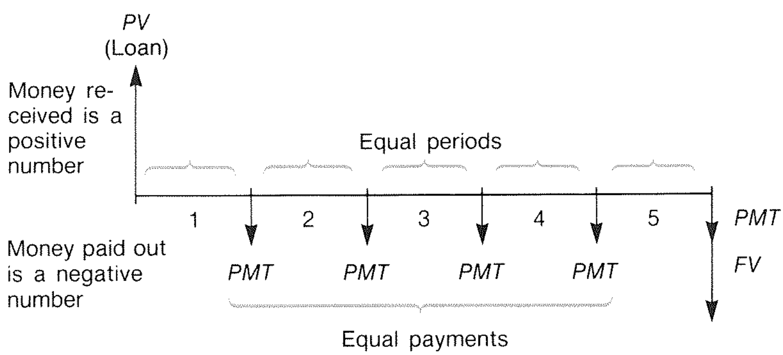


Figure 4-2. Loan From Borrower's Point of View

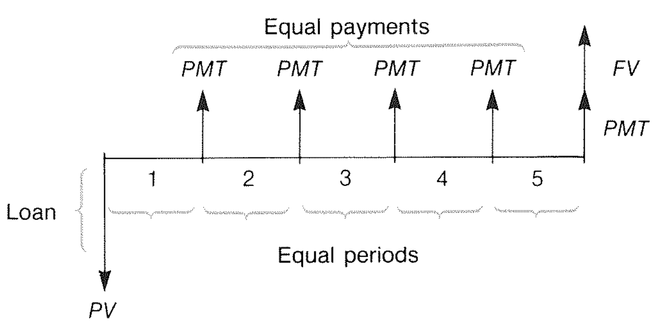


Figure 4-3. Loan From Lender's Point of View

Figures 4-4 and 4-5 illustrate payments occurring at the beginning and end of each period:

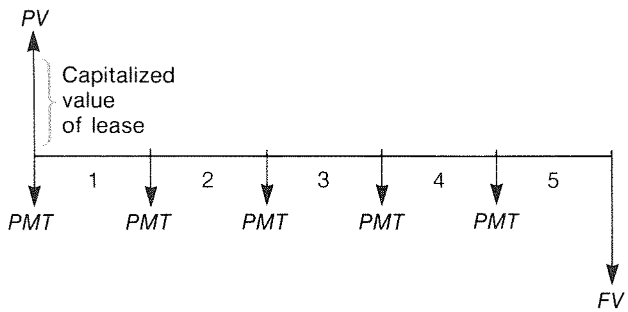


Figure 4-4. Lease Payments at Beginning of Each Period

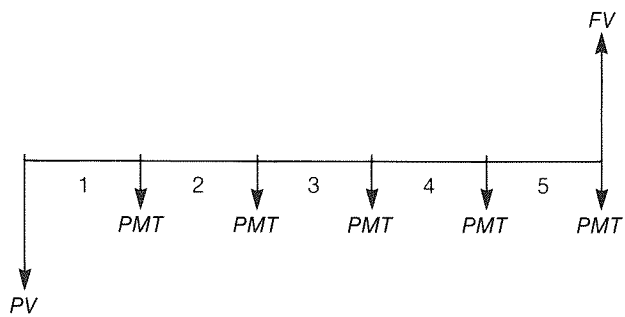


Figure 4-5. Deposits Into an Account at End of Each Period

TVM Calculations

The following general instructions explain how to use the TVM menu.

1. From the MAIN menu, press FIN , then TVM to display the TVM menu.
2. To clear the TVM variables, press [shift] CLEAR DATA .

3. Read the message that describes the number of payments per year and the Begin/End mode. If you must change either of these settings, press OTHER.
   - To change the number of payments per year, key in the new value and press P/YR.
   - To change the Begin/End mode, press BEG or END.
   - Press EXIT to return to the primary TVM menu.
4. To store the values you know, key in the number and press the appropriate menu key.
5. To calculate a value, press the appropriate menu key.

Some time-value-of-money calculations require that certain values be set to 0. For example, *FV* must be set to 0 when you are calculating the periodic payment (*PMT*) required to fully pay back a loan. There are two ways to set a value to 0:

- Before storing any values, press ■ CLEAR DATA to clear all the TVM variables.
- Store 0; for example, pressing 0 FV sets *FV* to 0.

Clearing the TVM Variables

The HP-19B retains the values stored in the TVM built-in variables until they are changed by storing or calculating a new value, or cleared by pressing ■ CLEAR DATA. Clearing variables sets them equal to 0.

When the HP-19B is displaying the primary TVM menu, pressing ■ CLEAR DATA clears *N*, *I%YR*, *PV*, *PMT*, and *FV*. When the secondary (OTHER) menu is displayed, pressing ■ CLEAR DATA sets the conditions 12 PMTS/YR: END MODE.

Loan Calculations

The following three examples illustrate several common loan calculations.

Example: A Car Loan. Part 1: You are financing the purchase of a car with a 3-year loan at 10.5% annual interest, compounded monthly. The purchase price of the car is $7,250. Your down payment is $1,500. What are your monthly payments? (Assume payments start one month after purchase—in other words, at the *end* of the first period.)

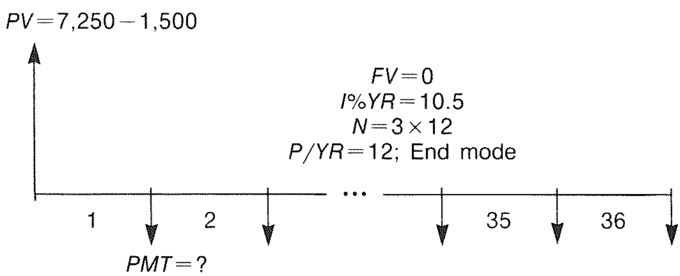


Figure 4-6. A Car Loan

Keys:	Display:	Description:
FIN TVM		Displays the TVM menu.
■ [CLEAR DATA]	0.00	Clears the TVM variables.
OTHER ■ [CLEAR DATA] [EXIT]	12 PMTS/YR: END MODE	If necessary, sets 12 payments/year; End mode.
3 ■ N	N=36.00	Stores the number of payments.
10.5 I%YR	I%YR=10.50	Stores the annual interest rate.
7250 [-] 1500 PV	PV=5,750.00	Stores the amount of the loan.

PMT	PMT=-186.89	Calculates the payment. The negative value means this is money *paid out.*

Part 2: What interest rate would you have to get to reduce your monthly payment by $10?

[+] 10 PMT	PMT=-176.89	Stores the reduced payment amount.
I%YR	I%YR=6.75	Calculates the annual interest rate.

Example: A Home Mortgage. You've decided that the maximum monthly mortgage payment you can afford is $630. You can make a $12,000 down payment, and annual interest rates are currently 11.5%. If you take out a 30-year mortgage, what is the maximum purchase price you can afford?

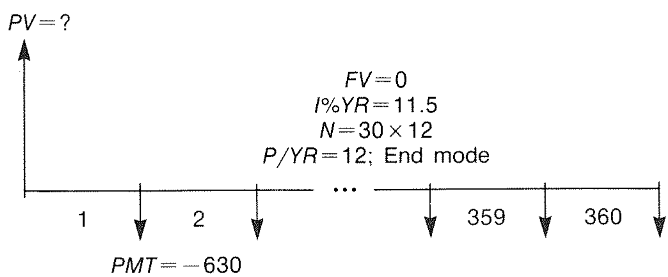


Figure 4-7. A Home Mortgage

Keys:	**Display:**	**Description:**
FIN TVM		Displays the TVM menu.
■ [CLEAR DATA]	0.00	Clears the TVM variables.
OTHER ■ [CLEAR DATA] [EXIT]	12 PMTS/YR: END MODE	If necessary, sets 12 payments/year; End mode.

30 N	N=360.00	Stores the number of payments.
11.5 I%YR	I%YR=11.50	Stores the annual interest rate.
630 +/- PMT	PMT=-630.00	Stores the monthly payment.
PV	PV=63,617.64	Calculates the loan amount.
+ 12000 =	75,617.64	Calculates the total price of the house (loan plus down payment).

Example: A Mortgage With a Balloon Payment. You've taken out a 25-year, $75,250 mortgage at 13.8% annual interest. You anticipate that you will own the house for four years and then sell it, repaying the loan in a "balloon payment." What will be the size of your balloon payment at the end of four years?

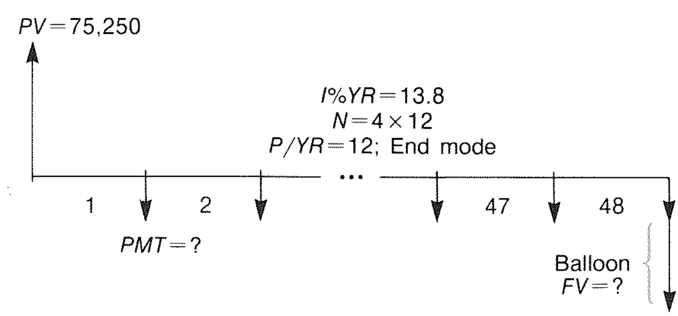


Figure 4-8. A Mortgage With a Balloon Payment

The problem is done in two steps:

1. Calculate the monthly payment.
2. Calculate the balloon payment after 4 years.

Keys:	Display:	Description:
FIN TVM		Displays the TVM menu.
■ CLEAR DATA	0.00	Clears the TVM variables.
OTHER ■ CLEAR DATA EXIT	12 PMTS/YR: END MODE	If necessary, sets 12 payments/year; End mode.

Step 1. Calculate *PMT* for the mortgage.

25 ■ N	N=300.00	Calculates the number of payments in 25 years and stores the value in *N*.
13.8 I%YR	I%YR=13.80	Stores the annual interest rate.
75250 PV	PV=75,250.00	Stores the amount of the loan.
PMT	PMT=-894.33	Calculates the monthly payment.

Step 2. Calculate the balloon payment after 4 years:

■ MATH RND EXIT PMT	PMT=-894.33	Stores the rounded value of *PMT*.*
4 ■ N	N=48.00	Stores the number of payments in 4 years.
FV	FV=-73,408.81	Calculates the balloon payment. This amount plus the last monthly payment repays the loan.

* The *PMT* calculated in the previous step was stored as the 12-digit number −894.330557971. The calculation of the balloon payment must use the actual dollars and cents monthly payment amount.

Amortization

The AMRT menu is used to calculate these values for a single loan payment or a series of loan payments:

- The balance of the loan after the payment(s) are made.
- The amount of the payment(s) applied toward interest.
- The amount of the payment(s) applied toward principal.

To display the AMRT menu, starting from the primary TVM menu, press OTHER, then AMRT.

Figure 4-9. The AMRT (Amortization) Menu

Table 4-2. AMRT Menu Keys

Menu Key	Description
#P	Stores the number of payments to be amortized, and calculates the amortization schedule. The value entered must be an integer in the range 1 through 1,200.
INT	Displays the amount of the payments applied toward interest.
PRIN	Displays the amount of the payments applied toward principal.
BAL	Displays the balance of the loan.
NEXT	Calculates the amortization schedule for the next set of payments, using the stored value of *#P*.
TABLE	Prints an amortization table (see page 204 for additional information.)

To calculate an amortization schedule, starting from the MAIN menu:

1. Press FIN , then TVM to display the primary TVM menu.
2. Press [CLEAR DATA] to clear *N*, *I%YR*, *PV*, *PMT*, and *FV* to 0.
3. Key in the annual interest rate and press I%YR .
4. Key in the amount of the loan (the principal) and press PV .
5. Key in the amount of the periodic payment* (use [+/-] to change the sign) and press PMT .
6. Press OTHER to display the secondary TVM menu.
7. If necessary, change the number of payments per year by keying in the value and pressing P/YR .
8. If necessary, change the Begin/End mode by pressing BEG or END .
9. Press AMRT .
10. Key in the number of payments to be amortized and press #P . The HP-19B displays the payments amortized, the balance of the loan, and the amount applied toward interest.
11. To display the amount applied toward the principal, press PRIN .
12. You can use the INT or BAL keys to redisplay those values on the calculator line.
13. To continue calculating the schedule for subsequent payments, do **a** or **b**:
    a. Key in the number of succeeding payments to be amortized and press #P .
    b. Press NEXT to use the previously stored value for #P.

* If you must calculate the periodic payment, substitute these instructions for steps 5 through 8, above:
1. Key in the total number of payments and press N .
2. Press OTHER to display the secondary TVM menu.
3. If you must change the number of payments per year, key in the value and press P/YR .
4. If necessary, change the Begin/End mode by pressing BEGIN or END .
5. Press [EXIT] to display the primary TVM menu.
6. Press PMT to calculate the payment.
7. Press OTHER .

To start the amortization schedule over from payment #1, press ■ CLEAR DATA and proceed starting at step #10.

Amortization calculations use values of *PV*, *PMT*, and *INT* rounded to the number of decimal places specified by the current display setting. (All 12 digits of *I%YR* are used.) However, the stored values of *PV* and *PMT* do not change.

Example: Amortization Schedule for a Home Mortgage.
Part 1: To purchase your new home, you have taken out a 30-year, $65,000 mortage at 12.5% annual interest. Your monthly payment is $693.72. Calculate the amount of the first year's and second year's payments that are applied toward principal and interest.

Keys:	Display:	Description:
FIN TVM		Displays the TVM menu.
■ CLEAR DATA	0.00	Clears the TVM variables.
12.5 I%YR	I%YR=12.50	Stores the annual interest rate.
65000 PV	PV=65,000.00	Stores the loan amount.
693.72 +/- PMT	PMT=-693.72	Stores the monthly payment.
OTHER		Displays the secondary TVM menu.
■ CLEAR DATA	12 PMTS/YR: END MODE	Sets 12 payments per year, End mode.
AMRT		Displays the AMRT menu.
12 #P	PAYMENTS: 1-12 BALANCE=64,788.52 INTEREST=-8,113.16	Calculates the amortization schedule for the first 12 payments.
PRIN	PRINCIPAL=-211.48	Displays the amount applied toward the principal for payments 1–12.

NEXT	PAYMENTS: 13-24 BALANCE=64,549.03 INTEREST=-8,085.15	Calculates the amortization schedule for the next 12 payments.
PRIN	PRINCIPAL=-239.49	Displays the amount applied toward the principal for payments 13 through 24.

Part 2: Calculate the loan balance after 3½ years. (Amortize 18 additional payments, since 42 − 24 = 18.)

18 #P	PAYMENTS: 25-42 BALANCE=64,129.05 INTEREST= -12,066.98	Calculates the amortization schedule for the next 18 months.

Savings Calculations

The following examples illustrate two common savings calculations.

Example: A Savings Account. You deposit $2,000 into a savings account that pays 7.2% annual interest, compounded annually. If you make no other deposits into the account, how long will it take for the account to contain $3,000?

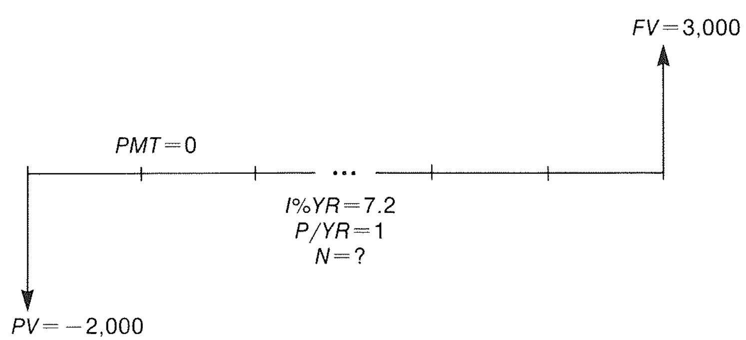


Figure 4-10. A Savings Account

Keys:	Display:	Description
FIN TVM		Displays the TVM menu.
■ CLEAR DATA	0.00	Clears TVM variables.
OTHER 1 P/YR END EXIT	1 PMTS/YR: END MODE	Sets 1 payment (period) per year, End mode.
7.2 I%YR	I%YR=7.20	Stores the annual interest rate.
2000 +/- PV	PV=-2,000.00	Stores the amount of the deposit.
3000 FV	FV=3,000.00	Stores 3,000 in *FV*.
N	N=5.83	Calculates the number of years.

Since the calculated value of *N* is between 5 and 6, it will take 6 years of annual compounding to achieve a balance of at least $3,000. The actual balance at the end of six years can be calculated:

6 N	N=6.00	Stores 6 in N.
FV	FV=3,035.28	Calculates the balance after six years.

Example: An Individual Retirement Account. You opened an individual retirement account on April 15, 1985, with a deposit of $2,000. Thereafter, you deposit $80.00 into the account semimonthly. The account pays 8.3% annual interest, compounded semimonthly. How much money will the account contain on April 15, 2000?

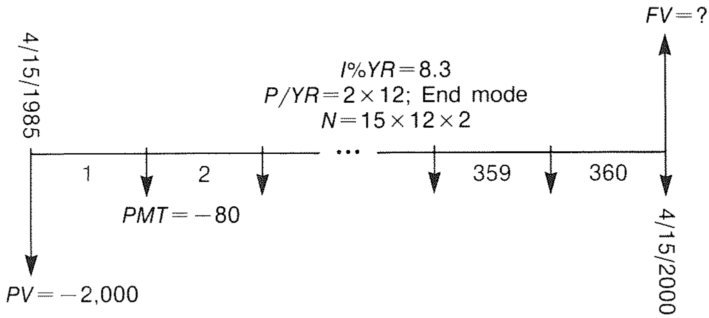


Figure 4-11. An Individual Retirement Account

Keys:	**Display:**	**Description:**
FIN TVM		Displays the TVM menu.
■ [CLEAR DATA]	0.00	Clears the TVM variables.
OTHER 24 P/YR END [EXIT]	24 PMTS/YR: END MODE	Sets 24 payments per year, End mode.
15 [×] 12 [×] 2 N	N=360.00	Calculates and stores the number of deposits.
8.3 I%YR	I%YR=8.30	Stores the annual interest rate.
2000 [+/-] PV	PV=-2,000.00	Stores the initial deposit.
80 [+/-] PMT	PMT=-80.00	Stores the semimonthly payment.
FV	FV=63,963.84	Calculates the balance after 15 years.

Leasing Calculations

Two common leasing calculations are calculating the lease payment necessary to achieve a specified yield, and finding the present value (capitalized value) of a lease.

Example: Calculating a Lease Payment. A new car valued at $13,500 is to be leased for 3 years, with an option to purchase the car for $7,500 at the end of the leasing period. What monthly payments, payable at the beginning of each month, are necessary to yield the lessor 14% annually?

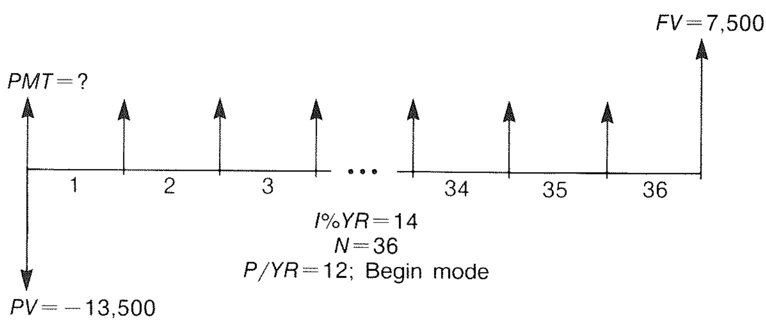


Figure 4-12. A Car Lease

Notice that the first lease payment occurs at the *beginning* of the first period.

Keys:	Display:	Description:
FIN TVM		Displays the TVM menu.
■ CLEAR DATA	0.00	Clears the TVM variables.
OTHER 12 P/YR BEG EXIT	12 PMTS/YR: BEGIN MODE	Sets 12 payments per year; Begin mode.
36 N	N=36.00	Stores the number of payments.

14 I%YR	I%YR=14.00	Stores the annual interest rate.
13500 [+/-] PV	PV=-13,500.00	Stores the present value of the car in *PV*.
7500 FV	FV=7,500.00	Stores the purchase option value in *FV*.
PMT	PMT=289.19	Calculates the monthly lease payment.

Example: Present Value of a Lease With Advance Payments and Option to Buy. Ratajak Dairy, Inc. is leasing a machine for 4 years. Monthly payments are $2,400; an additional $2,400 payment at the beginning of the leasing period replaces the final payment. The leasing agreement includes an option to buy the machine for $15,000 at the end of the leasing period. What is the capitalized value of the lease, assuming that the interest rate Ratajak pays to borrow funds is 18%, compounded monthly?

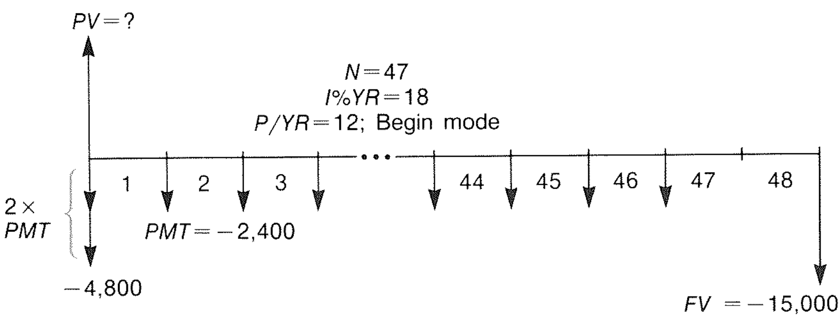


Figure 4-13. Lease With Advance Payments and Option to Buy

The problem is done in four steps:

1. Calculate the present value of the 47 monthly payments.
2. Add to this value the additional advance payment.
3. Find the present value of the buy option.
4. Sum the values calculated in steps 2 and 3.

Keys:	Display:	Description:
FIN TVM		Displays the TVM menu.
[CLEAR DATA]	0.00	Clears the TVM variables.
OTHER 12 P/YR BEGIN [EXIT]	12 PMTS/YR: BEGIN MODE	Sets 12 payments per year; Begin mode.

Step 1: Calculate the present value of the monthly payments:

47 N	N=47.00	Stores the number of payments.
18 I%YR	I%YR=18.00	Stores the annual interest rate.
2400 [+/-] PMT	PMT=-2,400.00	Stores the monthly payment.
PV	PV=81,735.58	Calculates the present (capitalized) value of the 47 monthly payments.

Step 2: Add the additional advance payment to *PV*. Store the answer.

[+] 2400 [=]	84,135.58	Calculates the present value of all the payments.
[STO] 0		Stores 84,135.58 in register 0.

Step 3: Find the present value of the buy option.

48 N	N=48.00	Stores the number of periods.
15000 [+/-] FV	FV=-15,000.00	Stores the buy option.
0 PMT	PMT=0.00	Clears *PMT*.

PV	PV=7,340.43	Calculates the present value of the buy option.

Step 4: Add the results of steps 2 and 3.

[+] [RCL] 0 [=]	91,476.00	Calculates the present (capitalized) value of the lease.

Interest Rate Conversions

Interest rates are generally stated as *nominal interest rates*. A nominal interest rate is an annual rate that is compounded *periodically*—for example, 18% per year, compounded monthly (12 times per year). When investments have different compounding periods, *effective interest rates* are used to compare them. The effective rate is the annual rate that would produce the same interest earnings as the nominal rate compounded *P* times per year. For example, earning 18% annual rate compounded monthly (nominal rate) is equivalent to earning 19.56% annual interest.

The ICONV (interest conversion) menu converts between nominal and effective interest rates, using either of two compounding methods:

- Periodic compounding; for example, quarterly, monthly, or daily.
- Continuous compounding.

To convert between nominal and effective interest rates, starting from the MAIN menu:

1. Press FIN, then ICONV to display the ICONV menu.
2. Select the compounding method— PER (periodic) or CONT (continuous).
3. Key in the nominal (or effective) interest rate and press NOM% (or EFF%).
4. For periodic compounding only: Key in the number of periods per year and press P.
5. Press EFF% (or NOM%) to calculate the effective (or nominal) annual interest rate.

Values of *EFF%* and *NOM%* are shared between the PER and CONT menus. For example, if you calculate an effective interest rate in CONT, that value remains stored in *EFF%* if you exit the CONT menu and enter the PER menu.

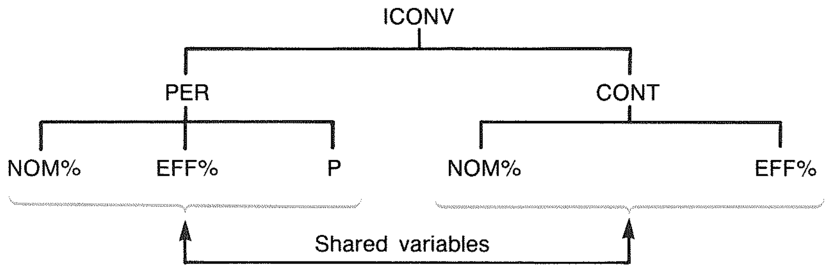


Figure 4-14. Shared Variables

Example: Converting From a Nominal to an Effective Interest Rate. You are considering opening a savings account in one of three banks. Which bank has the most favorable interest rate?

Bank #1: 6.7% annual interest, compounded quarterly.

Bank #2: 6.65% annual interest, compounded monthly.

Bank #3: 6.65% annual interest, compounded continuously.

Keys:	Display:	Description:
FIN ICONV		Displays the ICONV menu.
PER		Displays the PER menu.
■ CLEAR DATA	0.00	Clears the PER variables.
6.7 NOM%	NOM%=6.70	Stores the nominal annual interest rate for bank #1.

4 P	P=4.00	Stores the number of compounding periods per year.
EFF%	EFF%=6.87	Calculates the effective interest rate for bank #1.
6.65 NOM%	NOM%=6.65	Stores the nominal annual interest rate for bank #2.
12 P	P=12.00	Stores the number of compounding periods per year.
EFF%	EFF%=6.86	Calculates the effective interest rate for bank #2.
EXIT CONT		Displays the CONT menu. The previous values of *NOM%* and *EFF%* are retained.
EFF%	EFF%=6.88	Calculates the effective rate for bank #3.

The calculations show that bank #3 is offering the most favorable interest rate.

Clearing the ICONV Variables

NOM%, *EFF%*, and *P* are cleared when you enter the ICONV menu.

Pressing ■ CLEAR DATA in the PER or CONT menus clears *NOM%* and *EFF%*. In the PER menu, *P* is also cleared.

Compounding Periods Different from Payment Periods

The TVM menu assumes that the compounding periods and the payment periods are the same. However, regularly occurring savings-account deposits and withdrawals do not necessarily coincide with the bank's compounding periods. If they are not the same, you can adjust the interest rate using the ICONV menu, and then use the adjusted interest rate in the TVM menu.

Procedure for Calculating an Adjusted Interest Rate

1. Display the PER (periodic interest rate conversions) menu.
2. Calculate the effective annual interest rate from the nominal annual interest rate given by the bank:
   a. Store annual interest rate in NOM% .
   b. Store number of compounding periods per year in P .
   c. Press EFF% .
3. Calculate the nominal annual interest rate that corresponds to your payment periods:
   a. Store the number of regular payments or withdrawals per year in P .
   b. Press NOM% .
4. Display the TVM menu.
5. Store the just-calculated nominal interest rate in *I%YR* (press [STO] I%YR).
6. Store the number of payments or withdrawals per year in P/YR and set the appropriate Begin/End mode.
7. Continue with the TVM calculation:

   N = the total number of deposits or withdrawals.

   PV = the initial deposit.

   PMT = the amount of the regular, periodic deposit or withdrawal.

   FV = the future value.

When the interest rate is the unknown variable, first calculate *I%YR* in the TVM menu. This is the nominal annual rate that corresponds to your payment periods. Next, use the PER menu to convert this to the effective interest rate based on your payment periods. Finally, convert the effective rate to the nominal rate based on the bank's compounding periods.

Example: A Savings Account With Compounding Periods Different From Payment Periods. Starting today, you make monthly deposits of $25 into an account paying 5% interest compounded daily (365-day basis). At the end of seven years, how much will you receive from the account?

Keys:	**Display:**	**Description:**
FIN ICONV PER		Displays PER menu.
365 P	P=365.00	Stores bank's compounding periods.
5 NOM%	NOM%=5.00	Stores bank's nominal interest rate.
EFF%	EFF%=5.13	Calculates effective interest rate for daily compounding.
12 P	P=12.00	Stores number of deposits/year.
NOM%	NOM%=5.01	Calculates equivalent nominal interest rate for monthly compounding.
[EXIT] [EXIT] TVM	5.01	Displays TVM menu; *NOM%* value is still in calculator line.
[STO] I%YR	I%YR=5.01	Stores adjusted nominal interest rate in *I%YR*.

OTHER 12 P/YR BEG [EXIT]	12 PMTS/YR: BEGIN MODE	Sets 12 payments/year; Begin mode.
7 N	N=84.00	Stores known values.
25 [+/-] PMT	PMT=-25.00	
0 PV	PV=0.00	
FV	FV=2,519.61	Value of account in 7 years.

Example: Value of a Fund With Regular Withdrawals. What are the balances after 2 and 10 years of a fund that starts at $750,000, has $20,000 withdrawn at the beginning of each quarter, and earns 10% annual interest compounded monthly?

First, adjust the interest rate:

Keys:	Display:	Description:
FIN ICONV PER		Displays the PER menu.
12 P	P=12.00	Stores number of compounding periods.
10 NOM%	NOM%=10.00	Stores fund's nominal interest rate.
EFF%	EFF%=10.47	Calculates the effective interest rate.
4 P	P=4.00	Stores number of withdrawal periods per year.
NOM%	NOM%=10.08	Calculates adjusted nominal interest rate.

Use the adjusted nominal interest rate to calculate the future value of the fund:

[EXIT] [EXIT]		Displays TVM menu.
TVM	10.08	

STO I%YR	I%YR=10.08	Stores adjusted nominal interest rate in *I%YR*.
OTHER 4 P/YR BEG EXIT	4 PMTS/YR: BEGIN MODE	Sets 12 payments/year; Begin mode.
750000 +/- PV	PV=-750,000.00	Stores present (initial) value of fund.
20000 PMT	PMT=20,000.00	Stores withdrawal amount.
8 N	N=8.00	Stores number of withdrawals in 2 year.
FV	FV=736,033.78	Calculates value of fund at end of year 2.
40 N	N=40.00	Stores number of withdrawals in 10 years.
FV	FV=641,824.41	Calculates value of fund at end of year 10.

Example: Calculating the Interest Rate When Payment and Compounding Periods Differ. You have deposited $5,000 into an account, and plan to make monthly deposits of $200. What interest rate, compounded daily (365-day basis), must you earn for the account to grow to $21,000 after five years?

Keys:	Display:	Description:
FIN TVM		Displays the TVM menu.
■ CLEAR DATA	0.00	Clears the TVM variables.
OTHER ■ CLEAR DATA EXIT	12 PMTS/YR: END MODE	If necessary, sets 12 payments/year; End mode.

60 N	N=60.00	Stores known values.
5000 [+/-]		
PV	PV=-5,0000.00	
200 [+/-] PMT	PMT=-200.00	
21000 FV	FV=21,000.00	
I%YR	I%YR=6.43	Calculates required interest rate, monthly compounding.
[EXIT] ICONV		Displays PER menu.
PER	6.43	
[STO] NOM%	NOM%=6.43	Stores interest rate for monthly compounding.
12 P	P=12.00	Stores periods for monthly compounding.
EFF%	EFF%=6.62	Calculates effective rate for monthly compounding.
365 P	P=365.00	Stores periods for daily compounding.
NOM%	NOM%=6.41	Calculates equivalent interest rate for daily compounding.

Canadian Mortgages

In Canadian mortgages, interest is compounded semi-annually while payments are made monthly. The *Canadian mortgage factor* is calculated by converting the stated nominal interest rate (compounded semi-annually) to the nominal rate compounded monthly (the payment period). The factor is then used as the TVM variable *I%YR*.

See page 248 for an example of Canadian mortgages that uses a Solver equation.

Example: Calculating the Payment for a Canadian Mortgage. What is the monthly payment required to fully amortize a 30-year, $30,000 Canadian mortgage if the interest rate is 12%?

Keys:	Display:	Description:
FIN ICONV PER		Displays the PER menu.
12 NOM%	NOM%=12.00	Stores bank's stated rate.
2 P	P=2.00	Stores compounding periods/year.
EFF%	EFF%=12.36	Calculates effective interest.
12 P	P=12.00	Stores payment periods/year.
NOM%	NOM%=11.71	Calculates Canadian mortgage factor.
[EXIT] [EXIT] TVM	11.71	Displays TVM menu.
[STO] I%YR	I%YR=11.71	Stores Canadian mortgage factor as the annual interest.
OTHER ■ [CLEAR DATA] [EXIT]	12 PMTS/YR: END MODE	Sets 12 payments/year; End mode.
30 ■ N	N=360.00	Stores *N*.
30000 PV	PV=30,000.00	Stores *PV*.
0 FV	FV=0.00	Stores *FV*.
PMT	PMT=-301.92	Calculates monthly payment.

Additional TVM Examples

Yield of a Discounted (or Premium) Mortgage

The annual yield of a mortgage bought at a discount or premium can be calculated given the original mortgage amount (*PV*), interest rate (*I%YR*), periodic payment (*PMT*), balloon payment (if any) (*FV*), and the price paid for the mortgage (new *PV*).

Example: Yield of a Discounted Mortgage. An investor wishes to purchase a $100,000 mortgage taken out at 9% interest for 20 years. Since the mortgage was issued, 42 monthly payments have been made. The loan is to be paid in full (a *balloon payment*) at the end of its fifth year since issuance. What is the yield if the purchase price of the mortgage is $79,000?

1. Calculate *PMT* for the fully amortized loan ($N = 20 \times 12$, $FV = 0$, $PV = -100{,}000$, and $I\%YR = 9$).
2. Calculate the balloon payment (*FV*). (Use *PMT* from step 1, $N = 5 \times 12$).
3. Store the number of remaining payments until the balloon payment as *N* ($5 \times 12 - 42$) and the proposed purchase price as *PV* ($79,000); calculate *I%YR* (the annual yield).

Keys:	Display:	Description:
FIN TVM		Displays the TVM menu.
OTHER ■ CLEAR DATA EXIT	12 PMTS/YR: END MODE	Sets 12 payments/year; End mode.

Step 1: Calculate *PMT.*

20 ■ N	N=240.00	Stores *total* number of payments for a full 20-year loan with monthly payments.
9 I%YR 100000 +/- PV	I%YR=9.00 PV=-100,000.00	Stores interest rate and amount of original loan.
0 FV	FV=0.00	Sets *FV* to 0.
PMT	PMT=899.73	Calculates the monthly payment received from borrower.

Step 2. Enter the new value for *N* given a balloon in 5 years, then find *FV*, the amount of the balloon.

5 ■ N	N=60.00	Stores number of payments in five years.
FV	FV=88,707.05	Calculates the balloon due in 5 years.

Step 3: Enter the new values for *N* and *PV*, and calculate the new *I%YR:*

RCL N - 42 N	 N=18.00	Stores number of payments remaining until the balloon payment.
79000 +/- PV	 PV=-79,000	Stores proposed, discounted purchase price.
I%YR	I%YR=20.72	Calculates annual yield for discounted mortgage with balloon.

Loans With Fees

See appendix F for RPN keystrokes for the next two examples.

The *annual percentage rate,* APR, incorporates fees charged when a mortgage is issued, which effectively raises the interest rate. The actual amount received by the borrower (*PV*) is reduced, while the periodic payments remain the same.

Example: APR of a Loan With Fees. A borrower is charged two points for the issuance of a mortgage. (One point is equal to 1% of the mortgage amount.) If the mortgage amount is $60,000 for 30 years and the interest rate is 11½% annually with monthly payments, what APR is the borrower paying?

1. Calculate *PMT*, using *PV*=$60,000 and *I%YR*=11½%.
2. Adjust *PV* to reflect the amount of the loan minus the fees. Then, calculate the APR (*I%YR*), using the *PMT* calculated in step 1 (all other values remain the same).

Keys:	**Display:**	**Description:**
FIN TVM		Displays the TVM menu.
OTHER ■ [CLEAR DATA] [EXIT]	12 PMTS/YR: END MODE	If necessary, sets 12 payments/year; End mode.

Step 1: Calculate *PMT*.

30 ■ N	N=360.00	Stores number of monthly payments.
11.5 I%YR 60000 PV	I%YR=11.50 PV=60,000.00	Stores interest rate and amount of loan.
0 FV	FV=0.00	No balloon payment.
PMT	PMT=-594.17	Calculates monthly payment.

Step 2:

[RCL] PV [−] 2 [%] PV	PV=58,800.00	Stores actual amount of money received by borrower.
I%YR	I%YR=11.76	Calculates APR.

Example: Interest-Only Loan With Fees From the Lender's Point of View. A $1,000,000, 10-year, 10.5% (annual interest) *interest-only* loan has an origination fee of 3 points. What is the yield to the lender? Assume that the interest-only payments are made monthly. (*PMT* is $1,000,000 × 10.5% ÷ 12, *FV* is the entire loan amount, and *PV* is the loan amount minus the points.)

Keys:	**Display:**	**Description:**
FIN TVM		Displays the TVM menu.
OTHER [CLEAR DATA] [EXIT]	12 PMTS/YR: END MODE	If necessary, sets 12 payments/year; End mode.
10 N	N=120.00	Stores total number of payments.
1000000 [×] 10.5 [%] [÷] 12 PMT	PMT=8,750.00	Calculates and stores monthly payment.
1000000 FV	FV=1,000,000.00	Stores entire loan amount as balloon payment.
[−] 3 [%] [=] [+/−] PV	PV=-970,000.00	Stores amount borrowed (total − points).
I%YR	I%YR=11.00	Calculates APR, the yield to lender.

A Tax-Free Account

See appendix F for RPN keystrokes for this example.

You can use the TVM menu to calculate the future value of a tax-free or tax-deferred account, such as an IRA or Keogh account. Current tax law will determine the extent to which the account is tax-free. The purchasing power of the future value depends on the inflation rate and the duration of the account.

N	=	the number of payments until retirement.
I%YR	=	the annual dividend rate.
PV	=	the present value of the retirement account.
PMT	=	the amount of your deposit. (It must be constant for the duration of the account.)
FV	=	the future value of the retirement account.

Example: Future Value and Purchasing Power of a Tax-Free Account. Part 1: You open an individual retirement account with a dividend rate of 8.175%, and invest $2,000 at the beginning of each year for 35 years. Calculate the account balance at retirement.

Keys:	Display:	Description:
FIN TVM		Displays the TVM menu.
OTHER 1 P/YR BEG [EXIT]	1 PMTS/YR: BEGIN MODE	Sets 1 payment/year; Begin mode.
35 N	N=35.00	Stores number of payment periods until retirement.
8.175 I%YR	I%YR=8.18	Stores dividend rate.
0 PV	PV=0.00	Present value of account (before first payment) is zero.
2000 [+/-] PMT	PMT=-2,000.00	Stores annual deposit.

FV	FV=387,640.45	Calculates amount in account at retirement.

Part 2: How much have you paid into the account?

[RCL] PMT [×] [RCL] N [=]	-70,000.00	Calculates *PMT* × *N*.

Part 3: How much interest has the account earned. (The interest earned equals the difference between *FV* and the total amount deposited.)

[+] [RCL] FV [=]	317,640.45	Calculates interest you will earn.

Part 4: If your post-retirement tax rate is 15%, what is the after-tax future value of the account? Assume only interest is taxed.

[×] 15 [%] [=]	47,646.07	Calculates taxes, 15% of total interest.
[+/-] [+] [RCL] FV [=]	339,994.39	Subtracts taxes from total *FV* to calculate after-tax *FV*.

Part 5: Calculate the purchasing power of this amount in today's dollars, assuming an 8% annual inflation rate.

FV	FV=339,994.39	Purchasing power is $22,995.37
0 PMT	PMT=0.00	
8 I%YR	I%YR=8.00	
PV	PV=-22,995.37	

A Taxable Retirement Account

See appendix F for RPN keystrokes for this example.

The following example calculates the future value of a *taxable* retirement account that receives regular, annual payments. The annual tax on the interest is paid out of the account. (Assume the deposits have been taxed already.)

N = the number of years until retirement.

$I\%YR$ = the annual interest rate diminished by the tax rate: *interest rate* × (1 − *tax rate*).

PV = the current amount in the retirement account.

PMT = the amount of the annual payment.

FV = the future value of the retirement account.

Example: Future Value and Purchasing Power of a Taxable Retirement Account. Part 1: If you invest $3,000 each year for 35 years, with dividends taxed as ordinary income, how much will you have in the account at retirement? Assume an annual dividend rate of 8.175% and a tax rate of 28%, and that payments begin today.

Keys:	Display:	Description:
FIN TVM		Displays the TVM menu.
OTHER 1 P/YR BEG [EXIT]	1 PMTS/YR: BEGIN MODE	Sets 1 payment/year; Begin mode.
35 N	N=35.00	Stores years until retirement.
8.175 [−] 28 [%] I%YR	I%YR=5.89	Calculates and stores interest rate diminished by tax rate.
0 PV	PV=0.00	Stores 0 for present value.
3000 [+/−] PMT	PMT=-3,000.00	Stores annual payment.
FV	FV=345,505.61	Calculates future value of a taxed account.

Part 2: What will be the purchasing power of that amount in today's dollars, assuming 8% annual inflation?

0 PMT	PMT=0.00	Purchasing power is $23,368.11.
8 I%YR	I%YR=8.00	
PV	PV=-23,368.11	

5

Cash Flow Calculations

Introduction

The cash flow (CFLO) menu is used to analyze cash flows (money received or money paid out) of uneven amounts that occur at regular intervals.* Once you've entered the cash flows, you can:

- Calculate the total and internal rate of return of the cash flows.
- Calculate the net present value, net uniform series, and net future value for a specified periodic interest rate.
- Plot a graph of *NPV* versus *I%*.

The CFLO Menu

To display the cash flow (CFLO) menu, starting from the MAIN menu, press FIN, then CFLO. If you haven't previously used the CFLO menu, the HP-19B displays an empty cash flow list.

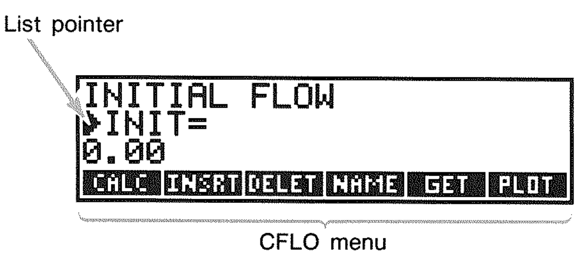


Figure 5-1. An Empty CFLO List

* You can use the CFLO menu for cash flows of equal amounts at regular intervals. However, these situations are handled more easily in the TVM menu.

The menu labels show the operations you can perform on the CFLO list (see table 5-1).

Table 5-1. CFLO Menu Keys

Menu Key	Description
CALC	Displays the CALC menu for calculating the *TOTAL*, *IRR%*, *NPV*, *NUS*, and *NFV*.
INSRT	Inserts cash flows into the list.
DELET	Deletes cash flows from the list.
NAME	Names the list.
GET	Switches from one list to another or creates a new list.
PLOT	Plots a graph of *NPV* versus *I%* for the cash flows in the current list.

If you have previously used the CFLO menu, the HP-19B displays the CFLO list you worked with most recently; the list pointer is positioned where it was the last time you displayed the list. You can press [↑] and [↓] to see more of the list.

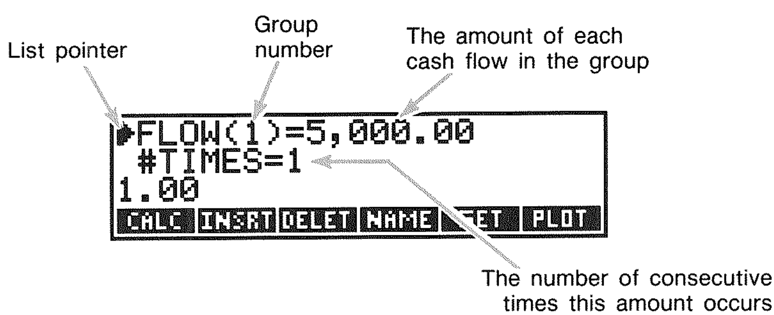


Figure 5-2. A CFLO List With Numbers Already In It

To display an empty list, you can:

- Clear the list by pressing ■ [CLEAR DATA] (see page 117 for additional information).
- Create a new list by pressing GET , then *NEW (see page 117 for additional information).

The maximum number of cash flows you can store depends on the amount of unused calculator memory. When calculator memory is otherwise empty, you can store a maximum of approximately 700 cash flows (simple or grouped).

Cash Flow Diagrams and Signs of Numbers

The sign conventions used for cash flow calculations are the same as those used in time-value-of-money calculations. Figure 5-3 illustrates a typical series of cash flows. Situations of this type, where there are no consecutive, equal cash flows, are called *simple cash flows.*

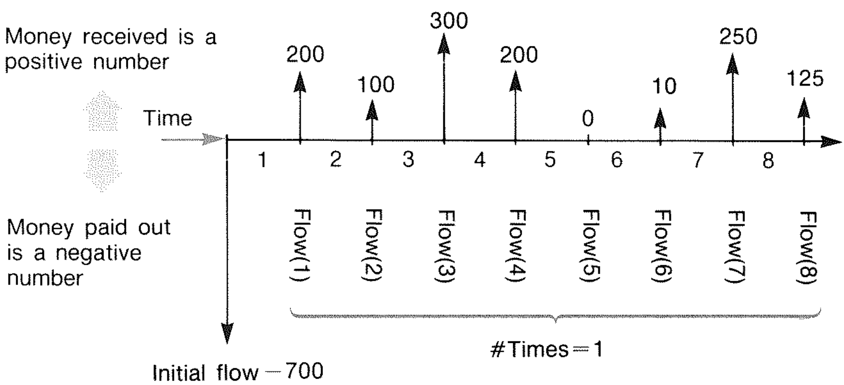


Figure 5-3. Simple Cash Flows

The horizontal line, representing time, is divided into equal compounding periods. The vertical lines represent the cash flows. For money received, the line points up; for money paid out, the line points down. In this case, the investor has invested $700, and this investment has generated a series of cash flows, starting at the end of the first period. Notice that there is no cash flow (0) for period five.

Figure 5-4 illustrates a cash flow diagram in which two series of consecutive, equal cash flows occur. Consecutive, equal cash flows are called *grouped cash flows.*

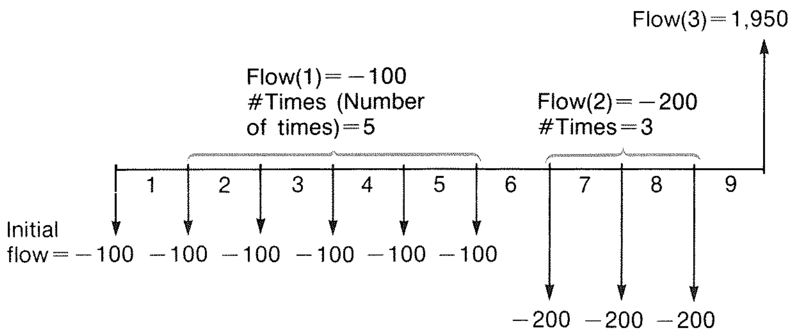


Figure 5-4. Grouped Cash Flows

After an initial payment of $100, the investor pays $100 at the end of periods 1 through 5, and $200 at the end of periods 6 through 8. The investment returns $1,950 at the end of period 9.

Entering Cash Flows

The list pointer (▸) designates the *current entry*, showing you where the next number you enter is placed. When the list is empty, the pointer is at the initial flow.

To enter cash flows into the CFLO list:

1. Make sure your cash flows are occurring at regular intervals and at the *end* of each period (see figure 5-3). If one or more periods are skipped, set their cash flows equal to 0. If consecutive, equal cash flows occur, you can group them to make entering the data easier (see figure 5-4).
2. Key in the value of the initial cash flow (remember the sign conventions—use [+/−], if necessary, to change the sign) and press [INPUT].
3. The pointer now points to FLOW(1). Key in the value for FLOW(1) and press [INPUT].

4. The pointer now points to #TIMES—the number of consecutive occurrences of FLOW(1). #TIMES has been automatically set to 1, and 1.00 is displayed on the calculator line as a typing aid. Do **a** or **b**:

   a. To retain the value 1, press [INPUT].*

   b. To change #TIMES, key in the number and press [INPUT].†

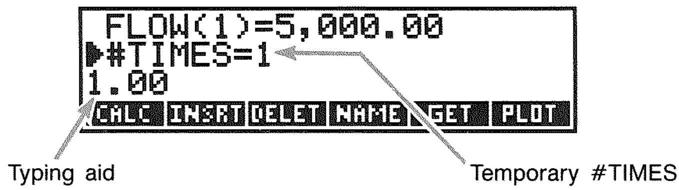


Figure 5-5. Entering #TIMES

5. Continue entering values. The HP-19B recognizes the end of the list when a flow is left blank (no value is entered).

Viewing and Editing the List

The [↑] and [↓] keys move the list pointer up and down the list. ■[↑] and ■[↓] move the pointer to the beginning and end of the list.

Changing a Number. To change an incorrect number after it's been entered into the list, position the pointer at the incorrect value. Key in the correct value and press [INPUT].

Inserting Cash Flows. To insert a flow into a list:

1. Position the list pointer below the place of insertion. For example, to insert a flow between FLOW(6) and FLOW(7), place the pointer at FLOW(7).

* Pressing [↓] to move the list pointer to the next cash flow also retains the value 1.

† The maximum value for #TIMES is 999.

2. Press INSRT .

3. Key in the value for the cash flow and press [INPUT]. Key in #TIMES and press [INPUT].

To add a cash flow to the bottom of the list, move the pointer to the bottom of the list (press ■[↓]) and enter the value and #TIMES.

Deleting Cash Flows. Pressing DELET deletes the current flow and its #TIMES.

Copying a List Number to the Calculator Line

To copy a number in the list into the calculator line, position the list pointer at that number and press [RCL] [INPUT].

Naming and Renaming a CFLO List

A new CFLO list has no name. Naming the list helps you locate it later, and also lets you have more than one CFLO list in memory. A list can remain nameless until you want to display (GET) a different CFLO list.

Naming a List. To name a list, press NAME . Type the name and press [INPUT].

List names can be up to 22 characters long and should not contain spaces or any of these characters: +, −, ×, ÷,), (, <, >, ^, :, =.*
The first three to five characters (some letters are wider than others) become a menu label when you press GET to switch lists.

Viewing the Name of the Current List. Press NAME to display the list name, then [EXIT] to return to the CFLO menu.

* NAME accepts these characters. However, names containing these characters cannot be used as the *name* in the Solver SIZEC and FLOW functions.

Renaming a List. To change the name of the current list, press NAME. Edit the current name and press [INPUT].

Switching CFLO Lists and Creating New Lists

When you press CFLO, the current list is the CFLO list you used most recently.

To switch to a different CFLO list or create a new list:

1. If you haven't already done so, name the current list.
2. Press GET. The GET menu contains a menu label for each named list, plus *NEW.*
3. Press the appropriate menu key. *NEW displays a new, empty list.

Clearing a CFLO List

Clearing a CFLO list erases all the numbers in the list . The memory used by the list becomes available for other information.

To clear the current CFLO list, press ■ [CLEAR DATA], then YES. If the list is named, the HP-19B lets you choose whether or not to clear the name.

Cash Flow Calculations

Press CALC to display the CALC menu. Table 5-2 describes the calculations you can do.

- To calculate the sum of the cash flows, press TOTAL.

* If the HP-19B display INSUFFICIENT MEMORY when you press GET, read the explanation of that message on page 316.

- To calculate the internal rate of return, press **IRR%**.* The HP-19B calculates the *periodic* rate of return. To calculate the annual return, multiply the periodic rate by the number of periods per year.
- To calculate net present value (**NPV**), net uniform series (**NUS**), and/or net future value (**NFV**):
  1. Key in the periodic interest rate, expressed as a percentage, and press **I%** .
  2. Press the menu key(s) for the calculation(s) you want to do.

Table 5-2. The CALC Menu for CFLO Lists

Menu Key	Description
TOTAL	Calculates the sum of the cash flows.
IRR%	Calculates the *internal rate of return*—the interest (discount) rate at which the net present value of the cash flows equals 0. For conventional investments*, the investment is attractive if *IRR%* is greater than the cost of capital.
I%	Stores the *periodic interest rate*, expressed as a percentage (sometimes called *cost of capital*, *discount rate*, *or required rate of return*).
NPV	Calculates the *net present value*—the present value of a series of cash flows plus the initial cost of the investment, computed for a specified periodic interest rate.
NUS	Calculates the *net uniform series*—the dollar amount of regular, equal cash flows having a present value equivalent to the net present value.
NFV	Calculates the *net future value* of a series of cash flows, calculated by finding the future value of the net present value.

* Conventional investments meet four criteria—(1) the initial cash flow is negative, (2) some flows following the initial flow are positive, (3) the sequence of cash flows changes sign only once, and (4) the sum (*TOTAL*) of the cash flows is positive.

* The calculations for internal rate of return are complex and may take a relatively long time. To halt the calculation, press any key. In certain cases, the HP-19B displays a message indicating that the calculation cannot continue without further information from you, or that there is no solution. See appendix B for additional information.

Example: Calculating IRR%, NPV, NUS, and NFV of an Investment. Part 1: An investor makes an initial investment of $80,000, and expects returns over the next five years as illustrated in figure 5-6.

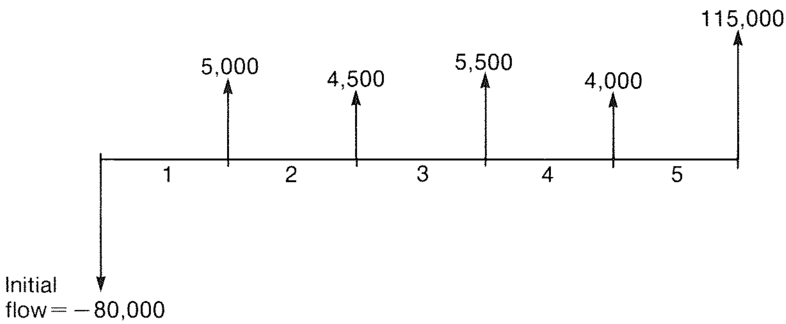


Figure 5-6. Cash Flows for an Investment

Calculate the total of the cash flows and the internal rate of return of the investment. Also calculate *NPV*, *NUS*, and *NFV*, assuming an annual interest rate of 10.5%.

Keys:	Display:	Description:
FIN CFLO *		Displays the CFLO menu.
■ [CLEAR DATA]		Clears the list.
YES	INITIAL FLOW ▶INIT=	
80000 [+/-] [INPUT]	INIT=-80,000.00	Enters the initial cash flow.
	▶FLOW(1)= #TIMES=	
5000 [INPUT]	FLOW(1)=5,000.00 ▶#TIMES=1	Enters FLOW(1).

* If you want to preserve the current list, skip the next step (pressing ■ [CLEAR DATA]). Instead, name the list (refer to page 116), and then press GET *NEW .

[INPUT]	▶FLOW(2)= #TIMES=	Enters 1 as the #TIMES for FLOW(1).
4500 [INPUT]	FLOW(2)=4,500.00 ▶#TIMES=1	Enters FLOW(2).
[INPUT]	▶FLOW(3)= #TIMES=	Enters #TIMES for FLOW(2).
5500 [INPUT]	FLOW(3)=5,500.00 ▶#TIMES=1	Enters FLOW(3).
[INPUT]	▶FLOW(4)= #TIMES=	Enters #TIMES for FLOW(3).
4000 [INPUT]	FLOW(4)=4,000.00 ▶#TIMES=1	Enters FLOW(4).
[INPUT]	▶FLOW(5)= #TIMES=	Enters #TIMES for FLOW(4).
115000 [INPUT]	FLOW(5)=115,000.00 ▶#TIMES=1	Enters FLOW(5).
[INPUT]	▶FLOW(6)= #TIMES=	Enters #TIMES for FLOW(5).
CALC		Displays the CALC menu.
TOTAL	TOTAL=54,000.00	Calculates the sum of the cash flows.
IRR%	IRR%=11.93	Calculates the internal rate of return.
10.5 I%	I%=10.50	Stores the periodic interest rate.
NPV NUS NFV	NPV=4,774.63 NUS=1,275.66 NFV=7,865.95	Calculates *NPV*, *NUS*, and *NFV*.

Part 2: Assuming the same interest rate, calculate *NPV* if cash flow #4 is reduced from $4,000 to $1,000.

[EXIT]	▶FLOW(6)= #TIMES=	Displays the number list.
[↑][↑][↑][↑]	▶FLOW(4)=4,000.00 #TIMES=1	Moves the pointer to FLOW(4).
1000 [INPUT]	FLOW(4)=1,000.00 ▶#TIMES=1	Changes FLOW(4) to $1,000.
CALC		Displays the CALC menu.
NPV	NPV=2,762.43	Calculates *NPV* for the edited list.

Example: An Investment With Grouped Cash Flows. You are considering an investment that requires a cash outlay of $50,000, with the promise of annual cash flows as shown in figure 5-7:

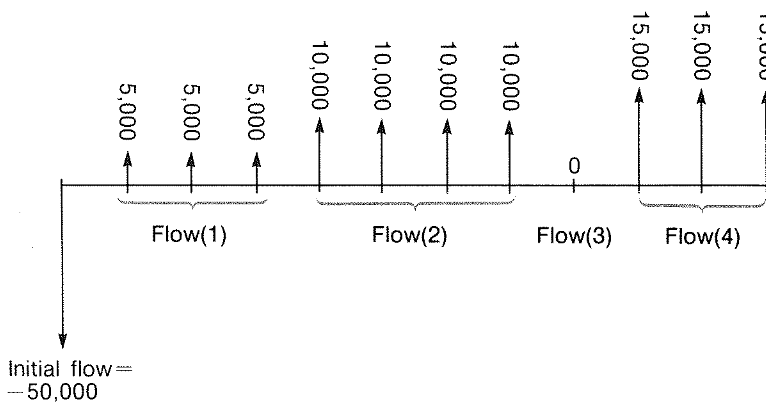


Figure 5-7. An Investment With Grouped Cash Flows

Calculate *IRR%*. Also, find *NPV* at an annual interest rate of 9%.

First, organize the data:

Group Number	Amount	Number of Times
Initial	−50,000	—
1	5,000	3
2	10,000	4
3	0	1
4	15,000	3

Keys:	Display:	Description:
FIN CFLO *		Displays the CFLO menu.
■ [CLEAR DATA] YES	INITIAL FLOW ▶INIT=	Clears the list.
50000 [+/-] [INPUT]	INIT=-50,000.00 ▶FLOW(1)= #TIMES=	Enters the initial cash flow.
5000 [INPUT]	FLOW(1)=5,000.00 ▶#TIMES=3	Enters FLOW(1).
3 [INPUT]	▶FLOW(2)= #TIMES=	Enters #TIMES for FLOW(1).
10000 [INPUT]	FLOW(2)=10,000.00 ▶#TIMES=4	Enters FLOW(2).
4 [INPUT]	▶FLOW(3)= #TIMES=	Enters #TIMES for FLOW(2).

* If you want to preserve the current number list, skip the next step (pressing ■ [CLEAR DATA]). Instead, name the list (refer to page 116), and then press GET *NEW .

0 [INPUT]	FLOW(3)=0.00 ▶#TIMES=	Enters FLOW(3)
[INPUT]	▶FLOW(4)= #TIMES=	FLOW(3) occurs once.
15000 [INPUT]	FLOW(4)=15,000 ▶#TIMES=3	Enters FLOW(4).
3 [INPUT]	▶FLOW(5)= #TIMES=	Enters #TIMES for FLOW(4).
CALC		Displays the CALC menu.
IRR%	IRR%=11.30	Calculates *IRR*%.
9 I%	I%=9.00	Stores the periodic (annual) interest rate.
NPV	NPV=6,728.63	Calculates *NPV*.

Example: An Investment With Quarterly Returns. You have been offered an opportunity to invest $20,000. The investment returns quarterly payments over four years as follows:

Year 1	4 payments of $500
Year 2	4 payments of $1,000
Year 3	4 payments of $2,000
Year 4	4 payments of $3,000

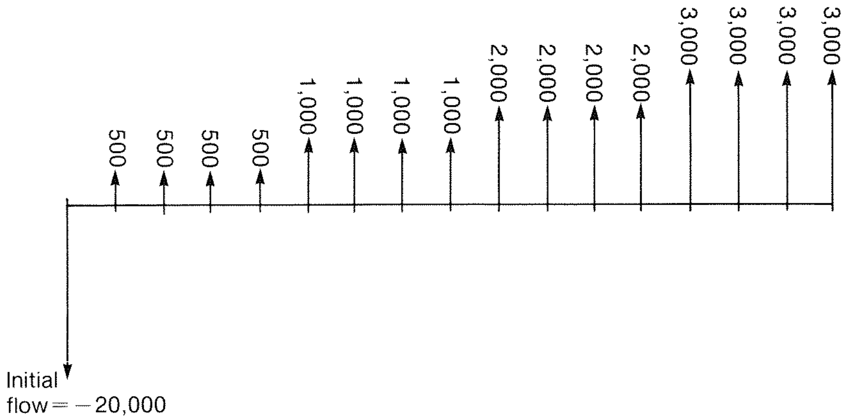


Figure 5-8. An Investment With Quarterly Returns

Calculate the annual rate of return for this investment.

Keys:	**Display:**	**Description:**
FIN CFLO *		Displays the CFLO menu.
■ CLEAR DATA YES	INITIAL FLOW ▶INIT=	Clears the list.
20000 +/- INPUT	INIT=-20,000.00	Enters the initial cash flow.
	▶FLOW(1)= #TIMES=	
500 INPUT	FLOW(1)=500.00 ▶#TIMES=1	Enters FLOW(1).
4 INPUT	▶FLOW(2)= #TIMES=	Enters #TIMES for FLOW(1).

* If you want to preserve the current number list, skip the next step (pressing ■ CLEAR DATA). Instead, name the list (refer to page 116), and then press GET *NEW .

1000 [INPUT] 4 [INPUT] 2000 [INPUT] 4 [INPUT] 3000 [INPUT] 4 [INPUT]	▶FLOW(5)= #TIMES=	Enters FLOW(2), FLOW(3) and FLOW(4).
CALC IRR%	IRR%=2.43	Calculates the periodic rate of return.
[×] 4 [=]	9.72	Calculates the nominal annual rate of return.

Plotting NPV Versus I%

Pressing PLOT in the CFLO menu displays a plot of *NPV* versus *I%* for the current CFLO list. Figure 5-9 illustrates a plot of *NPV* versus *I%* for the investment shown in figure 5-6. The horizontal axis is always scaled from *I%* = −18 to *I%* = 50 with tick marks at intervals of 5%. The vertical axis is automatically scaled to best show the shape of the curve.

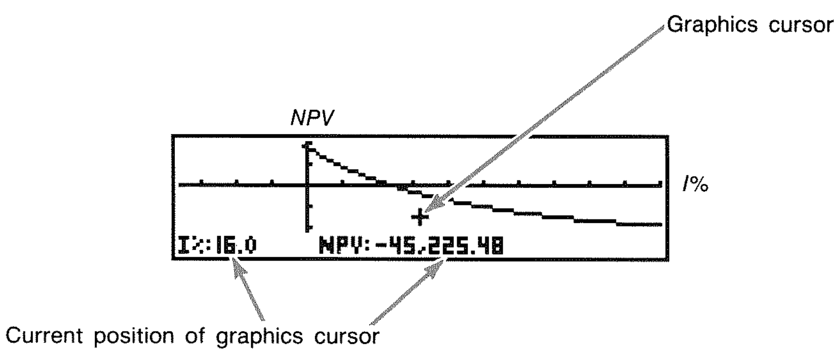


Figure 5-9. Plot of NPV Versus I%

You can use the arrow keys to move the graphics cursor to any position on the display. By positioning the graphics cursor at various places along the plotted curve, you can estimate *NPV* for various values of *I%*. If the plot crosses the horizontal axis, the point at which it crosses is an approximate solution for *IRR%*, since *I%*=*IRR%* when *NPV*=0. You should keep in mind that values of *NPV* and *I%* determined from the graph are not as accurate as calculations in the CALC menu.*

The plot of *NPV* versus *I%* is especially useful in situations where the calculation of *IRR%* in the CALC menu displays a message requesting a guess. When pressing IRR% displays:

```
IRR%>0 EXISTS; TO SEEK:
INPUT GUESS [STO]{IRR%}
```

The plot may help you estimate an appropriate guess (see "Storing a Guess for IRR%" on page 286.) When pressing IRR% displays:

```
MANY OR NO SOLUTIONS;
INPUT GUESS [STO]{IRR%}
```

the plot may show you whether a reasonable solution exists and help you estimate a guess to find it. If the plot does not cross the horizontal axis, probably no solution exists in the range −18% through +50%.

To erase the NPV profile and restore the CFLO menu, press [EXIT].

To halt plotting before a graph is complete, press any key.

Printing the NPV Profile. To print the graph of *NPV* versus *I%*, press [PRNT] while the graph is displayed.

* There is a loss of accuracy due to the limited resolution of the display. Use the CALC menu to calculate accurate values for *NPV*. Pressing [INPUT] while the plot is displayed stores the current *I%*-coordinate into *I%* in the CALC menu for later calculations of *NPV*, *NUS*, and *NFV*.

Additional CFLO Examples

Deposits Needed for a Future Expenditure

See appendix F for RPN keystrokes for this example.

Suppose you want to start saving now to accommodate a series of expenses in the future. To determine how much you need to save each period, you must know when you'll need the money, how much you'll need, and at what interest rate you can invest your deposits.

To do the calculation, enter the withdrawals into a CFLO list. Enter zero for all the deposits. Then, store the periodic interest rate in *I%* and calculate *NUS*. *NUS* is the periodic deposit equivalent to the withdrawals.

Example: Saving for College. Your daughter will be starting college in 12 years, at which time she will need $15,000 at the beginning of each year for four years. The fund earns 9% annually, compounded monthly, and you plan to make monthly deposits, starting at the end of the current month. How much should you deposit each month to meet her educational expenses?

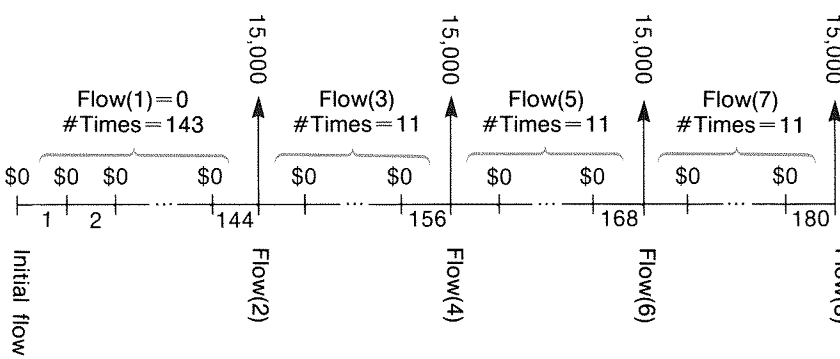


Figure 5-10. Cash Flows for a College Account

Keys:	Display:	Description:
FIN CFLO *		Displays the CFLO menu.
■ [CLEAR DATA] YES	▶INIT=	Clears the list.
0 [INPUT]	▶FLOW(1)= #TIMES=	Sets initial cash flow to zero.
0 [INPUT]	FLOW(1)=0.00 ▶#TIMES=1	Stores zero for FLOW(1).
√ 12 [×] 12 [−] 1 [INPUT]	▶FLOW(2)= #TIMES=	Stores 143 (for 11 yrs., 11 mos.) in #TIMES for FLOW(1).
15000 [INPUT]	FLOW(2)=15,000.00 ▶#TIMES=1	Stores amount of first withdrawal, at end of 12th year.
[INPUT]	▶FLOW(3)= #TIMES=	First withdrawal occurs once.
0 [INPUT]	FLOW(3)=0.00 ▶#TIMES=1	Stores cash flows of zero...
11 [INPUT]	▶FLOW(4)= #TIMES=	...for the next 11 months.
15000 [INPUT] [INPUT]	▶FLOW(5)= #TIMES=	Stores second withdrawal, for sophomore year.
0 [INPUT] 11 [INPUT]	▶FLOW(6)= #TIMES=	Stores cash flows of zero for the next 11 months.
15000 [INPUT] [INPUT]	▶FLOW(7)= #TIMES=	Stores third withdrawal, for junior year.

* If you want to preserve the current list, skip the next step (pressing ■ [CLEAR DATA]). Instead, name the list (refer to page 116), and then press GET *NEW .

0 [INPUT] 11 [INPUT]	▶FLOW(8)= #TIMES=	Stores cash flows of zero for the next 11 months.
15000 [INPUT] [INPUT]	▶FLOW(9)= #TIMES=	Stores fourth withdrawal, for senior year.
CALC		Displays the CALC menu.
9 [÷] 12 I%	I%=0.75	Stores the periodic (monthly) interest rate.
NUS	NUS=182.30	Calculates uniform payments equivalent to the series of withdrawals.

Modified Internal Rate of Return

When there is more than one sign change (positive to negative or negative to positive) in a series of cash flows, there is a potential for more than one *IRR%*.* The Modified Internal Rate of Return (MIRR) procedure is an alternative that can be used when your cash-flow situation has multiple sign changes. The procedure eliminates the sign change problem by utilizing reinvestment and borrowing rates that you specify. Negative cash flows are discounted at a *safe rate* that reflects the return on an investment in a liquid account. The figure generally used is a short-term security (T-bill) or bank passbook rate. Positive cash flows are reinvested at a *reinvestment rate* that reflects the return on an investment of comparable risk. An average return rate on recent market investments might be used.

To calculate MIRR:*

1. In the CFLO menu, calculate *NPV* of the *negative* cash flows at the *safe* rate. (Enter zero for any cash flow that is positive.) Store the result in register 0.

* For example, the cash flows in the following example have three sign changes and three positive internal rates of return—1.86, 14.35, and 29.02%. By plotting *NPV* versus *I%*, you can sometimes obtain good guesses for calculating *IRR%* in the CALC menu.

† Refer to page 258 for another way to calculate MIRR using a Solver equation.

2. Calculate *NFV* of the *positive* cash flows at the *reinvestment* rate. (Enter zero for any cash flow that is negative.) Store the result in register 1.
3. In the TVM menu, store the total number of periods in *N*, the *NPV* result in *PV*, and the *NFV* result in *FV*. Press I%YR to calculate the periodic interest rate. This is the modified internal rate of return, MIRR.

Example: Calculating Modified IRR Using the CFLO Menu. An investor has an investment opportunity with the monthly cash flows shown in figure 5-11. Calculate the MIRR using a safe rate of 8% and a reinvestment (risk) rate of 13%.

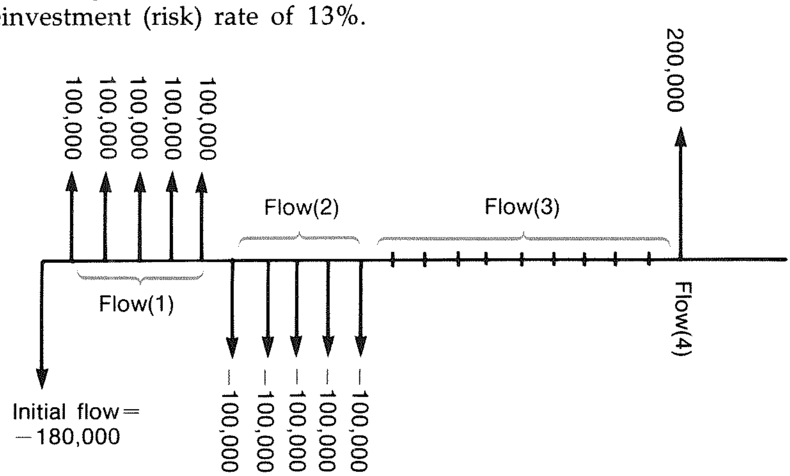


Figure 5-11. Cash Flows With Three Sign Changes

Keys:	**Display:**	**Description:**
FIN CFLO *		Displays the CFLO menu.
■ CLEAR DATA YES	▶INIT=	Clears the list.

* If you want to preserve the current list, skip the next step (pressing ■ CLEAR DATA). Instead, name the list (refer to page 116), and then press GET *NEW.

Step 1: Calculate *NPV* of the negative cash flows.

180000 [+/-] [INPUT]	▶FLOW(1)= #TIMES=	Stores initial cash flow.
0 [INPUT]	FLOW(1)=0.00 ▶#TIMES(1)=1	Stores FLOW(1) as zero since the flow amount is positive.
5 [INPUT]	▶FLOW(2)= #TIMES=	First cash flow occurs 5 times.
100000 [+/-] [INPUT]	FLOW(2)=-100,000.00 ▶#TIMES(2)=1	Stores FLOW(2).
5 [INPUT]	▶FLOW(3)=? #TIMES=	FLOW(2) occurs 5 times.

You can omit flows 3 and 4, since FLOW(3) = 0 and FLOW(4) is set to zero for this part.

CALC		Displays the CALC menu.
√8 [÷] 12 I%	I%=0.67	Stores monthly safe interest rate.
NPV	NPV=-654,136.81	Calculates *NPV* of negative cash flows.
[STO] 0	NPV=-654,136.81	Stores *NPV* in register 0.

Step 2: Calculate *NFV* for the positive cash flows:

[EXIT]	FLOW(3)=?	Displays the CFLO menu.
■ [CLEAR DATA] YES	▶INIT=	Clears the list.
0 [INPUT]	▶FLOW(1)= #TIMES=	Stores zero as the initial cash flow.

100000 [INPUT]		Stores the value and
5 [INPUT]	▶FLOW(2)= #TIMES=	#TIMES for FLOW(1).
0 [INPUT]		Stores FLOW(2).
5 [INPUT]	▶FLOW(3)= #TIMES=	
0 [INPUT]		Stores FLOW(3).
9 [INPUT]	▶FLOW(4)= #TIMES=	
200000 [INPUT]		Stores FLOW(4).
[INPUT]	▶FLOW(5)= #TIMES=	
CALC		Displays the CALC menu.
√13 [÷] 12 I%	I%=1.08	Stores monthly reinvestment rate.
NFV	NFV=800,582.75	Calculates *NFV* of positive cash flows.
[STO] 1	NFV=800,582.75	Stores *NFV* in register 1.

Step 3: Use the TVM menu to calculate MIRR:

[EXIT] [EXIT] TVM		Displays TVM menu.
OTHER ■ [CLEAR DATA] [EXIT]	12 PMTS/YR: END MODE	If necessary, sets 12 periods/year; End mode.
20 N	N=20.00	Stores total number of investment periods.
[RCL] 0 PV	PV=-654,136.81	Stores *NPV* of negative cash flows as *PV*.

RCL 1 FV	FV=800,582.75	Stores *NFV* of positive cash flows as *FV*.
0 PMT	PMT=0.00	Stores zero in *PMT*.
I%YR	I%YR=12.18	Calculates annual MIRR.

6

Bonds and Depreciation

Bonds

The BOND menu calculates the *yield to maturity* or *price* of a bond. It also calculates *yield to call* on a coupon date and *accrued interest*. You can specify:

- *The calendar basis*: 30/360 or actual/actual (days per month/days per year). Municipal, state, and corporate bonds issued in the United States are typically 30/360. U.S. Treasury bonds are actual/actual.
- *The coupon payments*: semi-annual or annual. Most U.S. bonds are semi-annual.

The BOND Menu

To display the BOND menu, starting from the MAIN menu, press FIN, then BOND. A message indicates the type of bond currently specified: 30/360 or A/A; SEMI ANNUAL or ANNUAL.

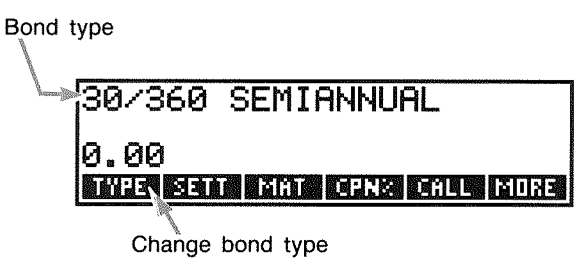


Figure 6-1. The BOND Menu

Table 6-1. BOND Menu Keys

Menu Key	Description
TYPE	Displays a menu for changing bond types: 30/360 or actual/actual calendars, semi-annual or annual coupon payments.
SETT	Stores the settlement (purchase) date using the current date format (*MM.DDYYYY* or *DD.MMYYYY*; see pages 177 and 178).
MAT	Stores the maturity date *or* call date using the current date format. (The call date must coincide with a coupon date.)
CPN%	Stores the annual coupon rate as a percentage.
CALL	Stores the call price per $100 face value. (To calculate *yield to maturity, CALL* must equal 100.)
	↓ MORE ↑
YLD%	Stores or calculates the yield to maturity or yield to call date, expressed as an annual percentage.
PRICE	Stores or calculates the price per $100 face value.
ACCRU	Calculates the interest accrued from the last coupon-payment date until the settlement date, per $100 face value.

Bond Calculations

Values in the BOND menu are expressed *per $100 face value* or as a *percentage*. A *CALL* value of 102 means that the bond will be worth $102 for every $100 of face value when called.*

To calculate the price or yield of a bond:

1. Display the BOND menu by pressing FIN BOND .
2. Press ■ CLEAR DATA . This sets *CALL*=100 and clears the other bond variables.

* Some corporate bonds in the United States use the convention that the price of the bond is set to 100 if the coupon percent equals the yield percent, whether or not the settlement date is a coupon date. The BOND menu does *not* use this convention.

3. Define the type of bond. If the message in the display does not match the type you want, press TYPE .

Figure 6-2. Changing the Bond Type

- 360 sets the calendar basis to a 30-day month, 360-day year.
- A/A sets the calendar basis to the actual calendar month and year.
- SEMI sets semi-annual coupon payments.
- ANN sets annual coupon payments.

Press [EXIT] to restore the BOND menu.

4. Key in the settlement date (*MM.DDYYYY* or *DD.MMYYYY* format; see pages 177 and 178) and press SETT .
5. Key in the maturity date *or* call date and press MAT . (The call date must coinside with a coupon date.)
6. Key in the coupon rate as an annual percent and press CPN% .
7. Key in the call value, if any, and press CALL . For a bond held to maturity, the *CALL* value must equal 100.
8. Press MORE . Then:
   a. To calculate the price, key in the yield and press YLD% . Press PRICE .
   b. To calculate the yield, key in the price and press PRICE . Press YLD% .
   c. To calculate the accrued interest, press ACCRU . The *total* amount owed the seller is *PRICE* + *ACCRU*.

Example: Price and Yield of a Bond. Part 1: What price should you pay on August 10, 1987 for a 6¾% U.S. Treasury bond that matures on May 1, 2002 if you wish a yield of 8¼%? The calendar basis is actual/actual and the coupon payments are semi-annual. (The example assumes *MM.DDYYYY* date format.)

Keys:	Display:	Description:
FIN BOND ■ CLEAR DATA		Clears BOND variables; sets *CALL* to 100.
TYPE A/A SEMI EXIT	A/A SEMIANNUAL	Sets bond type, if necessary.
8.101987 SETT	SETT= 08/10/1987 MON	Stores settlement date.
5.012002 MAT	MAT=05/01/2002 WED	Stores maturity date.
6.75 CPN%	CPN%=6.75	Stores annual coupon rate.
MORE 8.25 YLD%	YLD%=8.25	Stores desired yield.
PRICE	PRICE=87.33	Calculates the price per $100 face value.
√ + ACCRU	87.33+1.85	Adds accrued interest owed the seller.
√ =	89.18	Calculates the net price.

Part 2: If the market quote for the bond were 88⅜, what yield would that represent?

Keys:	Display:	Description:
√ 3 ÷ 8 + 88 PRICE	PRICE=88.38	Stores decimal equivalent of 88⅜.
YLD%	YLD%=8.12	Calculates yield to maturity.

Example: A Bond With a Call Feature. Part 1: What is the price of a 6% corporate bond maturing on March 3, 2007 and purchased on May 2, 1988 to yield 5.7%? Use a 30/360 calendar with semi-annual coupon payments.

Keys:	Display:	Description:
FIN BOND ■ [CLEAR DATA]		Clears BOND variables; sets *CALL* to 100.
TYPE 360 SEMI [EXIT]	30/360 SEMIANNUAL	Sets bond type, if necessary.
5.021988 SETT	SETT= 05/02/1988 MON	Stores purchase date (*MM.DDYYYY* format).
3.032007 MAT	MAT=03/03/2007 SAT	Stores maturity date.
6 CPN%	CPN%=6.00	
MORE 5.7 YLD%	YLD%=5.70	
PRICE	PRICE=103.43	Calculates price.

Part 2: The bond is callable on March 3, 1991 (a coupon date), at a value of 102.75. What is the yield to the call date?

Keys:	Display:	Description:
MORE 3.031991 MAT	MAT=03/03/1991 SUN	Stores the call date.
102.75 CALL	CALL=102.75	Stores the call value.
MORE YLD%	YLD%=5.58	Calculates yield to call.

Example: A Zero-Coupon Bond. Calculate the price of a zero-coupon, semi-annual bond using a 30/360 calendar basis. The bond was purchased on May 19, 1986, matures on June 30, 2000, and has a yield to maturity of 10%.

Keys:	Display:	Description:
FIN BOND ■ CLEAR DATA		Clears BOND variables, sets *CALL* to 100.
TYPE 360 SEMI EXIT	30/360 SEMIANNUAL	Sets type, if necessary.
5.191986 SETT	SETT= 05/19/1986 MON	Stores purchase date (*MM.DDYYYY* format).
6.302000 MAT	MAT=06/30/2000 FRI	Stores maturity date.
0 CPN%	CPN%=0.00	Sets coupon rate to zero.
MORE 10 YLD%	YLD%=10.00	Stores yield to maturity.
PRICE	PRICE=25.23	Calculates price.

Clearing the BOND Variables

The calculator retains the values of the BOND variables until you clear them by pressing ■ CLEAR DATA while the BOND menu is displayed. Clearing sets *CALL* to 100. All the other variables are set to 0.

Depreciation

The DEPRC (*depreciation*) menu calculates depreciation values and remaining depreciable values (*RDV*) one year at a time. The methods available are:

- Declining balance.
- Sum-of-the-years'-digits.
- Straight line.
- Accelerated Cost Recovery System.

The DEPRC Menu

To display the DEPRC menu, starting from the MAIN menu, press FIN then DEPRC .

Figure 6-3. The DEPRC (Depreciation) Menu

Table 6-2. DEPRC (Depreciation) Menu Keys

Menu Key	Description
BASIS	Stores the depreciable-cost basis of the asset at acquisition.
SALV	Stores the salvage value of the asset at the end of its useful life. If there is no salvage value, set *SALV*=0.
LIFE	Stores the expected useful life (in whole years) of the asset.
ACRS%	Stores the appropriate Accelerated Cost Recovery System percentage from the published ACRS tables.
ACRS	Calculates the ACRS deduction based on *BASIS* and *ACRS%*. (*SALV*, *LIFE*, *FACT%*, and *YR#* are ignored).
	↓ MORE ↑
YR#	Stores the number of the year for which the depreciation will be calculated; must be an integer.
FACT%	For the declining balance method: stores the declining-balance factor as a percentage of the straight-line rate.
DB	Calculates the declining-balance depreciation for the year and the *RDV*.*
SOYD	Calculates the sum-of-the-years'-digits depreciation for the year and the *RDV*.*
SL	Calculates the straight-line depreciation for the year and the *RDV*.*

* *RDV* (remaining depreciable value) = *BASIS* − *SALV* − accumulated depreciation.

Depreciation for the DB, SOYD, and SL Methods

To calculate the depreciation for an asset:

1. To display the DEPRC menu, press FIN DEPRC .

2. Optional: Clear the DEPRC variables by pressing ■ CLEAR DATA

3. Define the characteristics of the asset:

   a. Key in the cost basis and press BASIS .

   b. Key in the salvage value and press SALV . If there is no salvage value, enter zero.

   c. Key in the useful life and press LIFE .

4. Press MORE to display the rest of the DEPRC menu.

5. Key in the year number for the depreciation you want to calculate (1, 2, 3, etc.) and press YR# .

6. *If you are using the declining-balance method,* enter the DB factor (a percentage) and press FACT% . (For example, for a rate 1 ¼ times *SL,* enter 125.)

7. Press DB , SOYD , or SL to calculate the appropriate depreciation and remaining depreciable value (*RDV*).*

6. To calculate the depreciation for another year, store a new year number (*YR#*) and press DB , SOYD , or SL again.

Example: Declining-Balance Depreciation. Part 1: A metalworking machine, purchased for $10,000, is to be depreciated over 5 years. Its salvage value is estimated at $500. Find the depreciation and remaining depreciable value for each of the first 3 years of the machine's life using the double-declining-balance method (200% of the straight-line rate).

* The calculated values of *RDV, DB, SOYD,* and *SL* are rounded internally to the number number of decimal places specified by the current display setting.

Keys:	Display:	Description:
FIN DEPRC		Displays DEPRC menu.
10000 BASIS	BASIS=10,000.00	Cost basis.
500 SALV	SALV=500.00	Salvage value.
5 LIFE	LIFE=5.00	Useful life.
MORE 1 YR#	YR#=1.00	First year of depreciation.
200 FACT%	FACT%=200.00	DB percentage factor.
DB	RDV=5,500.00 DB=4,000.00	Calculates remaining depreciable value after 1st year (*BASIS* − *SALV* − 4,000) and depreciation for 1st year (⅕ × *BASIS* × 2).
2 YR# DB	RDV=3,100.00 DB=2,400.00	Calculates *RDV* and depreciation, year 2.
3 YR# DB	RDV=1,660.00 DB=1,440.00	Calculates *RDV* and depreciation, year 3.

Part 2: For comparison, calculate the straight-line depreciation for year 3.

SL	RDV=3,800.00 SL=1,900.00	Calculates straight-line depreciation after 3rd year.

Depreciation for the ACRS Method

To calculate the amount of tax deduction under the U.S. Accelerated Cost Recovery System:

1. To display the DEPRC menu, press FIN DEPRC.
2. Enter the cost basis of the asset and press BASIS.
3. The Internal Revenue Service publishes tables that list the percentage of an asset's basis that can be deducted each year of its prescribed life. Look up that value, enter it, and press ACRS%.
4. Press ACRS to calculate the value of the deduction.

Example: ACRS Deductions. Use the ACRS method to find the income-tax deduction for a $25,000 asset over 3 years of a 5-year life. Use this hypothetical ACRS table:

Year	Percentage Deductible
1	15
2	25
3	20
4	20
5	20

Keys:	Display:	Description:
FIN DEPRC		DEPRC menu.
25000 BASIS	BASIS=25,000.00	Enters basis.
15 ACRS%	ACRS%=15.00	Tabular value, year 1.
ACRS	ACRS=3,750.00	Deduction in first year.
25 ACRS%	ACRS%=25.00	Tabular value, year 2.
ACRS	ACRS=6,250.00	Deduction in second year.

20 ACRS%	ACRS%=20.00	Tabular value, year 3.
ACRS	ACRS=5,000.00	Deduction in third year.

Clearing the Depreciation Variables

The calculator retains the values of the DEPRC variables until you clear them by pressing ■ CLEAR DATA while either page of the DEPRC menu is displayed. Clearing the DEPRC variables sets *#YR* and *LIFE* equal to 1, and the other variables to 0.

Partial-Year Depreciation

When the acquisition date of an asset does not coincide with the start of the tax or fiscal year, the calculations of DB, SOYD, or SL depreciation involve fractions of years. The number of years in which the depreciation occurs is equal to the life of the asset plus 1.

For example, suppose you acquired an asset in October and wanted to depreciate it for 3 years. (Your fiscal year begins January 1st; the three months from October to December equals ¼th of a year.) The depreciation schedule affects parts of 4 years (see figure 6-4).

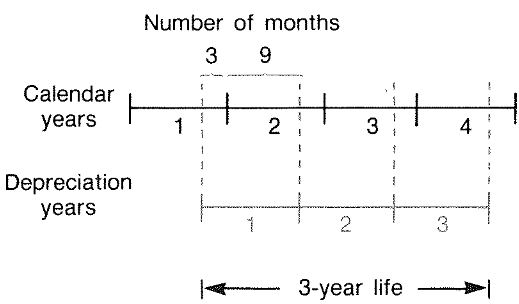


Figure 6-4. Partial-Year Depreciation

For SL depreciation, the partial-year calculation is easy: calculate the SL value, then use 1/4 of that value for the first year, the full amount the second and third years, and 3/4 of that amount the fourth year.

For DB and SOYD depreciation, each year's depreciation value is different:

Calendar Year	DB and SOYD Depreciation Value
1 (Oct.–Dec.)	1/4 × year #1
2 (Jan.–Dec.)	(3/4 × year #1) + (1/4 × year #2)
3 (Jan.–Dec.)	(3/4 × year #2) + (1/4 × year #3)
4 (Jan.–Sept.)	3/4 × year #3

Example: Partial-Year Depreciation. A movie camera bought for $12,000 has a useful life of 10 years with a salvage value of $500. Using the sum-of-the-years'-digits method, find the amount of depreciation for the fourth calendar year. Assume the first depreciation year was 11 months long.

Depreciation for the fourth calendar year equals 1/12 × year #3 plus 11/12 × year #4:

Keys:	**Display:**	**Description:**
FIN DEPRC		Displays DEPRC menu.
12000 BASIS 500 SALV 10 LIFE MORE 3 YR#	BASIS=12,000.00 SALV=500.00 LIFE=10.00 YR#=3.00	Stores known values.
SOYD	RDV=5,854.55 SOYD=1,672.73	Calculates depreciation for year #3.
÷ 12 = STO 1	 139.39	Stores 1/12 of depreciation for year #3.

4 YR# SOYD	RDV=4,390.91 SOYD=1,463.64	Calculates depreciation for year #4.
✓ [×] 11 [÷] 12 [=]	1,341.67	Calculates 11/12 of depreciation for year #4.
✓ [+] [RCL] 1 [=]	1,481.06	Calculates total depreciation for 4th calendar year.

7

Totals, Subtotals, and Statistics

Introduction

The SUM menu is used to calculate the running total of a list of numbers and to do statistical calculations. As you enter the numbers, the HP-19B displays the running total. Once the list of numbers has been entered, you can:

- Calculate subtotals for any portions of the list.
- Calculate the mean, median, standard deviation, and range (largest number minus the smallest number), and display the largest and smallest number in the list.
- Sort the list from smallest number to largest number.
- Display a histogram showing the frequency distribution of the data.
- Do curve-fitting and forecasting calculations using two SUM lists and one of four models—linear, exponential, logarithmic, and power. (Curve fitting for the linear model is called *linear regression*.) You can also display a plot of the x,y-data and the fitted curve.
- Calculate a weighted mean and grouped standard deviation.
- Calculate the summation statistics Σx, Σx^2, Σy, Σy^2, and Σxy.

You can store many separate SUM lists of varying lengths, up to the amount of available memory. When memory is otherwise empty, a maximum of approximately 800 numbers can be stored.

The SUM Menu

To display the SUM menu, press **SUM** in the MAIN menu. If you haven't previously used the SUM menu, the HP-19B displays an empty SUM list.

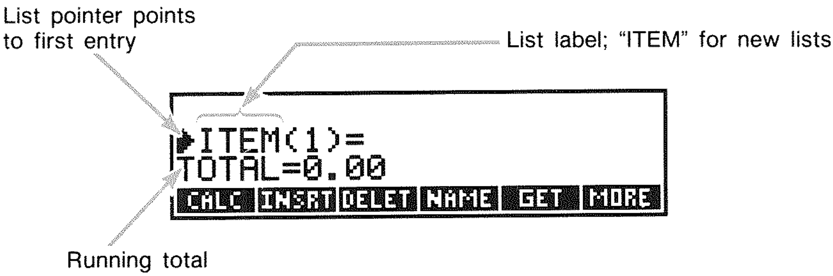


Figure 7-1. SUM Menu and Empty SUM List

The menu labels show the operations you can perform on your SUM list. Table 7-1 briefly describes these operations.

Table 7-1. SUM Menu Keys

Menu Key	Description
CALC	Displays the CALC menu, which is used to do statistical calculations and to display historgrams and *x*,*y*-plots.
INSRT	Inserts numbers into the list.
DELET	Deletes numbers from the list.
NAME	Names the list.
GET	Switches from one list to another or creates a new list.
	↓ MORE ↑
COPY	Copies the contents of the list to another list.
LABEL	Provides individual entries or all entries in the list with a label of your choice.
START	For calculating subtotals; designates the current entry as the start of the subtotal range.
SUBT	Calculates the subtotal from *START* to the current entry.

If you have previously used the SUM menu, the HP-19B displays the SUM list you worked with most recently, and the list pointer is positioned where it was the last time you displayed the list. You can press [↑] or [↓] to see more of the list.

Figure 7-2. A SUM List With Information Already In It

To display an empty list, you can:

- Clear the list by pressing [■] [CLEAR DATA] and following the directions on page 160.
- Create a new list by pressing GET, then *NEW (see page 159 for additional information).

Entering Numbers and Viewing the Running Total

The list pointer (▶) points to the *current entry*, showing you where the next number you enter is placed. When the list is empty, the current entry is ITEM(1) and the TOTAL = 0.00.

To enter numbers into the empty list:

1. Key in the first number; if necessary, press [+/-] to change the sign.

2. Press [INPUT] to enter the number as ITEM(1). Line 3 displays the updated running total, and the list pointer now points to ITEM(2).

```
 ITEM(1)=267.82
▶ITEM(2)=
TOTAL=267.82
 CALC  INSRT DELET NAME  GET  MORE
```

Figure 7-3. SUM List After Entering One Number

3. To enter ITEM(2), key in the value and press [INPUT]. The updated running total is displayed on the calculator line, and the list pointer now points to ITEM(3).

```
 ITEM(2)=837.42
▶ITEM(3)=
TOTAL=1,105.24
 CALC  INSRT DELET NAME  GET  MORE
```

Figure 7-4. SUM List After Entering Two Numbers

4. Continue entering values for ITEM(3), ITEM(4), etc. The HP-19B recognizes the end of the list when an entry is left blank (no value is entered).

Viewing and Editing the List

The [↑] and [↓] keys move the list pointer up and down the list one number at a time. ▒[↑] and ▒[↓] move the pointer to the beginning and end of the list. Moving the list pointer does not affect the value of the running total.

Changing a Number. To change an incorrect number after it has been entered, position the pointer at the incorrect value. Key in the correct value and press [INPUT].

Inserting Entries. To insert values into a list:

1. Position the list pointer at the place of insertion. For example, to insert a number between the sixth and seventh entries, place the list pointer at the seventh entry.
2. Press INSRT .
3. Key in the value and press [INPUT]. The new running total is displayed.

To add a number to the bottom of the list, press [■] [↓] and enter the new value.

Deleting Entries. Pressing DELET deletes the current entry.

Example: Updating a Checkbook. On May 30, a checking account balance was $267.82. The transactions for the first 10 days in June are:

Date	Transaction	Amount	Date	Transaction	Amount
5/31	Balance	267.82	6/3	Check	−128.90
6/1	Deposit	837.42	6/7	Check	−65.35
6/1	Check	−368.23	6/10	Deposit	55.67
6/2	Check	−45.36			

Update the checkbook by calculating the running balance.

Keys:	Display:	Description:
SUM *		Displays the SUM menu.
[■] [CLEAR DATA]		Clears the list.
YES	▶ITEM(1)= TOTAL=0.00	

* If you want to preserve the current list, skip the next step (pressing [■] [CLEAR DATA]). Instead, name the list (refer to page 158), and then press GET *NEW .

267.82 [INPUT]	ITEM(1)=267.82 ▶ITEM(2)= TOTAL=267.82	Enters the beginning balance.
837.42 [INPUT]	ITEM(2)=837.42 ▶ITEM(3)= TOTAL=1,105.24	Enters the deposit on 6/1.
368.23 [+/-] [INPUT] 45.36 [+/-] [INPUT] 128.90 [+/-] [INPUT] 65.35 [+/-] [INPUT] 55.67 [INPUT]	ITEM(7)=55.67 ▶ITEM(8)= TOTAL=553.07	Enters the remaining transactions.

Copying a List Number to the Calculator Line

To copy a number in the list into the calculator line, position the list pointer at that number and press [RCL] [INPUT].

Calculating Subtotals

The subtotal keys START and SUBT calculate the sum of a portion of the list—for example, all the numbers from ITEM(2) through ITEM(6). To calculate a subtotal:

1. Display the subtotal keys in the second page of the SUM menu (display the SUM menu and press MORE).

2. Use [↑] or [↓] to move the list pointer to the first number in the range. Press START. (*START* can be either endpoint of the subtotal range; for example, *START* can be either ITEM(2) *or* ITEM(6) to calculate the subtotal for items 2 through 6.)
3. Move the list pointer to the final number in the range and press SUBT to display the subtotal.
4. To calculate other subtotals using the same *START*, move the list pointer to the new final number and press SUBT.

To view the *START* designation, press [RCL] START.

START remains assigned to the same entry when the list is edited. For example, if *START* is set to ITEM(10), deleting an item before ITEM(10) causes *START* to become ITEM(9). Deleting the entry designated *START* reassigns *START* to the next entry.

START is set to 1 when you clear the list or switch to another list.

Example: Calculating Subtotals. During your 8-day vacation, you spend the following amounts for food:

Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8
46.50	85.89	62.10	30.45	15.95	145.60	42.46	125.90

Calculate the total amount for food. Also calculate the food expenses for days 1 through 3, 4 through 6, and 2 through 7.

Keys:	Display:	Description:
SUM *		Displays the SUM menu.
■ [CLEAR DATA] YES		Clears the list.

* If you want to preserve the current list, skip the next step (pressing ■ [CLEAR DATA]). Instead, name the list (refer to page 158), and then press GET *NEW.

Keys:	Display:	Description:
46.5 [INPUT] 85.89 [INPUT] 62.1 [INPUT] 30.45 [INPUT] 15.95 [INPUT] 145.6 [INPUT] 42.46 [INPUT] 125.9 [INPUT]	ITEM(8)=125.90 ▶ITEM(9)= TOTAL=554.85	Enters expenses, calculates *TOTAL*.
MORE		Displays second page of SUM menu.
▆ [↑] START	START:ITEM(1) ▶ITEM(1)=46.50 TOTAL=554.85	Designates ITEM(1) as *START*.
[↓] [↓] SUBT	START:ITEM(1) ▶ITEM(3)=62.10 SUBTOTAL=194.49	Calculates subtotal for entries 1 through 3.
[↓] START	START:ITEM(4) ▶ITEM(4)=30.45 194.49	Designates ITEM(4) as *START*.
[↓] [↓] SUBT	START:ITEM(4) ▶ITEM(6)=145.60 SUBTOTAL=192.00	Calculates subtotal for entries 4 through 6.
[↓] START	START:ITEM(7) ▶ITEM(7)=42.46 192.00	Designates ITEM(7) as *START*.
▆ [↑] [↓] SUBT	START:ITEM(7) ▶ITEM(2)=85.89 SUBTOTAL=382.45	Calculates subtotal for entries 2 through 7.

Labeling Entries

New SUM lists automatically use the label "ITEM" for all entries. The LABEL key allows you to replace ITEM with a *global* label for the entire list, and *individual* labels for single entries. The maximum length of a label is 8 characters, not including the entry number.

Labeling entries does not affect their entry numbers. For example, if you label ITEM(6) with the individual label SALES, it appears in the list as SALES(6).

Individual Labels

To label the current entry, or to edit its existing individual label:

1. Press LABEL .
2. Type (or edit) the label and press CURR or [INPUT].

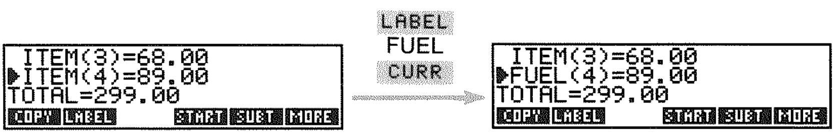


Figure 7-5. Entering an Individual Label

Deleting an individual label changes it to the current global label (or to ITEM), and reclaims the memory used to store the individual label.

To delete an individual label, press LABEL . Clear the edit line (press [CLEAR]) and press CURR or [INPUT].

Global Labels

When you enter a global label, it is given to all entries in the list that do not have individual labels. To enter a global label:

1. Press LABEL .
2. Type the global label and press GLOBL .

Figure 7-6. Entering the Global Label

Deleting the global label restores the label ITEM to all entries that do not have individual labels, and reclaims the memory used to store the global label.

To delete the global label, press LABEL . Clear the edit line, if necessary (press [CLEAR]), and press GLOBL .

Deleting All Your Labels

Deleting all your labels restores the label "ITEM" to all the numbers in the current list, and reclaims the memory used to store your individual and global labels. To delete your labels:

1. Press [CLEAR DATA], then OTHER .
2. Press LABEL .

Example: Travel Expenses. Today is April 10, and you are leaving on a trip tomorrow. Create a list for storing tomorrow's travel expenses.

Keys:	Display:	Description:
SUM *		Displays the SUM menu.
■ [CLEAR DATA] YES	▶ITEM(1)= TOTAL=0.00	Clears the list.
MORE LABEL 11APRIL GLOBL	▶11APRIL(1)=0.00 TOTAL=0.00	Enters global label.
0 [INPUT]	11APRIL(1)=0.00 ▶11APRIL(2)= TOTAL=0.00	Entry 1 will be a heading.†
LABEL AIRFARE CURR	11APRIL(1)=0.00 ▶AIRFARE(2)= TOTAL=0.00	Enters label for airfare.
0 [INPUT]	AIRFARE(2)=0.00 ▶11APRIL(3)= TOTAL=0.00	Enters 0 temporarily for airfare.
LABEL CAR RENT CURR 0 [INPUT]	CAR RENT(3)=0.00 ▶11APRIL(4)= TOTAL=0.00	Enters label for car rental.
LABEL MEALS CURR 0 [INPUT]	MEALS(4)=0.00 ▶11APRIL(5)= TOTAL=0.00	Enters heading for meals.

* If you want to preserve the current list, skip the next step (pressing ■ [CLEAR DATA]). Instead, name the list (refer to page 158), and then press GET *NEW .

† You cannot use "heading" entries if you want to do statistical calculations (for example, mean, standard deviation, curve fitting) with the data in the list, since the entry's value (0) would be included in the calculations.

LABEL Enters label for lodgings.
HOTEL CURR

```
 MEALS(4)=0.00
▶HOTEL(5)=
 TOTAL=0.00
```

Your plane ticket cost $345.00. Enter that value into the travel template.

[■] [↑] [↓] 345
INPUT

```
 AIRFARE(2)=345.00
▶CAR RENT(3)=0.00
 TOTAL=345.00
```

You can continue to add as many expense entries as you'd like. Notice how the global label helps you remember which list you are in. On April 11, as you travel, you can replace each 0 entry with the appropriate value as you incur the expense.

Naming and Renaming a SUM List

A new SUM list has no name. Naming a list helps you to locate it later, and also lets you have more than one SUM list in memory. A SUM list can remain nameless until you want to display (GET) a different SUM list.

Naming a List. To name a list, press NAME . Type the name and press [INPUT].

List names can be up to 22 characters long and should not contain spaces or any of the these characters: +, −, ×, ÷,), (, <, >, ^, :, =.* The first three to five characters (some letters are wider than others) become a menu label when you press GET to switch lists.

Viewing the Name of the Current List. Press NAME to display the list name, then [EXIT] to return to the SUM menu.

* NAME will accept these characters. However, names containing these characters cannot be used as the *name* parameter in the Solver SIZES and ITEM functions.

Renaming a List. To change the name of the current list, press NAME . Edit the current name and press [INPUT].

Switching SUM Lists and Creating New Lists

When you press SUM , the current list is the SUM list you used most recently. To switch to a different list or create a new list:

1. If you haven't already done so, name the current list.
2. Press GET . The GET menu contains a menu label for each named list, plus *NEW .*
3. Press the appropriate menu key. *NEW displays a new, empty list.

Copying a SUM List

COPY copies the current list—both numbers and labels—to a new list created by the copying process, or to a previously existing list. To copy the list:

1. Press COPY .
2. Type the name of the destination list and press [INPUT].

If the destination list does not yet exist, it is created. If the list exists, the HP-19B displays:

```
NAME ALREADY USED:
REPLACE EXISTING LIST?
```

Pressing YES overwrites the previous contents of the destination list with the copied information.

* If the HP-19B displays INSUFFICIENT MEMORY when you press GET , read the explanation of that message on page 338.

Clearing and Deleting the SUM List

Pressing [CLEAR DATA] in the SUM menu displays a menu of two or three options:

- YES deletes the entire list—both numbers and labels—and reclaims all the memory used by the list. If you named the list, the HP-19B lets you choose whether or not to delete the name.
- NO lets you recover from pressing [CLEAR DATA] accidently.
- OTHER is useful if you've entered any individual or global labels. Pressing OTHER displays two choices:
  - NUM clears all the numbers to zero without affecting the labels. Thus, you are left with a labeled "template" for entering new data. No memory is reclaimed, since memory is required to store the zeros.
  - LABEL clears all the list labels to the original label, "ITEM," without affecting the numbers. The memory used by the individual and global labels is reclaimed.

Example: Copying and Clearing a List. Name the travel expense list entered in the previous example "T4/11." Also, make a copy of the list for the next day's (4/12) travel expenses.

Continuing from the last step of the previous example ("Travel Expenses"):

Keys:	Display:	Description:
MORE NAME T4/11 [INPUT]	NAME IS NOW: ▶T4/11	Names the list.
MORE COPY T4/12 [INPUT]		Copies contents of T4/11 to new list T4/12.

You should now assign T4/12 an appropriate global label and clear the numbers copied from T4/11:

MORE GET T4/12	▶11APRIL(1)=0.00 TOTAL=345.00	Displays list T4/12.
MORE LABEL 12APRIL GLOBL	▶12APRIL(1)=0.00 TOTAL=345.00	Edits global label.
■ [CLEAR DATA] OTHER NUM	▶12APRIL(1)=0.00 TOTAL=0.00	Clears the numbers copied from T4/11.

Statistics Calculations

Press CALC to display the CALC menu, which is described in table 7-2 on page 162. To display a particular statistical value, press the appropriate menu key.

Example: Statistics Calculations. The Wechsler-Ellendman Canal Boat Shoe Shop had the following phone bills during the past six months:

Month	Phone Expense	Month	Phone Expense
1. May	$340	4. August	$780
2. June	$175	5. September	$245
3. July	$450	6. October	$625

Table 7-2. The CALC Menu for SUM Lists

Menu Key	Description
TOTAL	Displays the sum of all the numbers in the list.
MEAN	Displays the mean (arithmetic average) of the set of numbers.
MEDN	Displays the median. If you were to sort the numbers from smallest to the largest, the median number would be half-way down the list. If there is an even number of items, the median is the mean of the middle two numbers.
STDEV	Displays the standard deviation.* The standard deviation is a measure of how dispersed the numbers are about the mean. The larger the standard deviation, the larger the spread. A standard deviation of 0 means that all the numbers are identical.
RANG	Displays the difference between the largest and smallest number.
	↓ MORE ↑
MIN	Displays the smallest (minimum) number in the list.
MAX	Displays the largest (maximum) number in the list.
SORT	Sorts the list so that numbers are ordered from smallest to largest. The labels remain associated with their numbers.
FRCST	Displays the FRCST menu, which is used to do calculations based on two SUM lists—curve fitting, estimation (forecasting), weighted mean and grouped standard deviation, summation statistics. (See page 166.)
HIST	Draws a histogram illustrating the frequency distribution of the data in the list (see page 164).

* The equation used by the HP-19B calculates the *sample* standard deviation. The equation assumes that the list of numbers is a sampling of a larger, complete set of data. If the list is, in fact, the entire set of data, the *true population standard deviation* can be computed by calculating the mean of the original list, placing that value into the list, and then calculating the standard deviation.

Calculate the mean, median, and standard deviation of the monthly phone bills. Then, display the smallest value in the list.

Keys:	**Display:**	**Description:**
SUM *		Displays the SUM menu.
■ [CLEAR DATA]		Clears the list.
YES	▶ITEM(1)= TOTAL=0.00	
340 [INPUT]	ITEM(1)=340.00 ▶ITEM(2)= TOTAL=340.00	Enters May's phone bill.
175 [INPUT]	ITEM(2)=175.00 ▶ITEM(3)= TOTAL=515.00	Enters June's phone bill.
450 [INPUT] 780 [INPUT] 245 [INPUT]		Enters the phone bills for July through October.
625 [INPUT]	ITEM(6)=625.00 ▶ITEM(7)= TOTAL=2,615.00	
CALC	2,615.00	Displays the CALC menu.
MEAN	MEAN=435.83	Calculates the mean.
MEDN	MEDIAN=395.00	Calculates the median.
STDEV	STDEV=231.55	Calculates the standard deviation.
MORE		Displays the rest of the CALC menu.
MIN	MIN=175.00	Displays the smallest number.

* If you want to preserve the current list, skip the next step (pressing ■ [CLEAR DATA]). Instead, name the list (refer to page 158), and then press GET *NEW .

Drawing a Histogram

Pressing `HIST` draws a histogram illustrating the frequency distribution of values in the current SUM list. For example, figure 7-7 illustrates a histogram of the following data:

12.7	5.9	18.2	−34.7
18.8	78.6	−24.6	9.8
46.3	38.6	−1.4	89.4

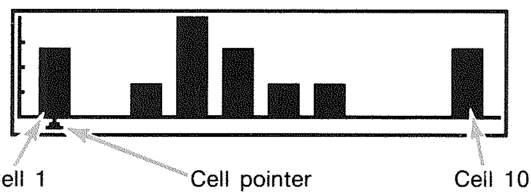


Figure 7-7. A Histogram of SUM Data

Each of the histogram's 10 cells represents one tenth the range of values in the list. The height of each cell is proportional to the number of entries in that range. Pressing [EXIT] restores the CALC menu.

To view additional information about a cell, use [←] or [→] to position the cell pointer under the cell, then press and hold down [INPUT].

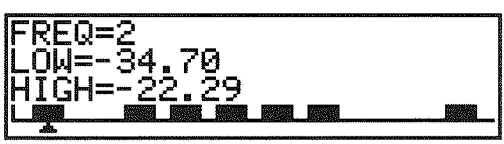


Figure 7-8. Displaying Cell Information

The *FREQUENCY* is the number of entries with values in the range *LOW* through *HIGH*.*

* Cells 1 through 9 include items in the range *LOW* ≤ ITEM < *HIGH*; for cell 10, *LOW* ≤ ITEM ≤ *HIGH*.

Printing the Histogram. To print the histogram, press [PRNT]. To print the cell information display, press [INPUT] and then quickly hold down [ON] and press [PRNT].

Calculations That Use Two SUM Lists

The following calculations use two SUM lists, and are done using the FRCST menu (see table 7-3). Displaying and using the FRCST menu is covered separately for the three types of calculations done:

- Curve fitting and forecasting, which fits x- and y-data to a linear, logarithmic, exponential, or power curve, and uses the results to calculate estimates.
- Weighted mean and grouped standard deviation (see page 171).
- The summation statistics Σx, Σx^2, Σy, Σy^2, Σxy (see page 173).

Curve Fitting and Forecasting

Curve fitting is a technique for finding a mathematical relationship between two sets of numbers. The two sets of numbers are referred to as x-values and y-values. Curve fitting uses two SUM lists—one for the x-values and one for the y-values. You can select one of four relationships (or models*), which are illustrated in figure 7-9 on page 167.

- Linear; $y = B + Mx$ (B is the y-intercept, M is the slope of the line).
- Logarithmic; $y = B + M \ln x$ (all x-values must be positive).
- Exponential; $y = Be^{Mx}$ (all y-values must be positive).
- Power curve; $y = Bx^M$ (all x-values and all y-values must be positive).

* The HP-19B calculates the exponential, logarithmic, and power models using transformations that allow the data to be fitted by standard linear regression. These transformations are:

- Logarithmic; $y = B + M \ln x$; y versus $\ln(x)$.
- Exponential; $\ln(y) = \ln(B) + Mx$; $\ln(y)$ versus x.
- Power curve; $\ln(y) = \ln(B) + M \ln(x)$; $\ln(y)$ versus $\ln(x)$.

Table 7-3. FRCST Menu Keys

Menu Key	Description
XLIST YLIST	Forecasting variables; used to store an *x*-value to calculate a *y*-value, or vice versa.
CORR *	Displays the *correlation coefficient.* The correlation coefficient is a number between −1 and +1 that measures how closely the x,y-values match the calculated curve. A correlation coefficient close to +1 or −1 indicates that the *x*,*y*-values lie close to the calculated curve; a correlation coefficient close to 0 indicates the curve is a poor fit to the values.
M *	Displays the value of *M* for the model. (For the linear model, this is the slope of the line.)
B *	Displays the value of *B* for the model. (For the linear model, this is the y-intercept of the line.)
	↓ MORE
PLOT	Plots the *x*,*y* data and the curve calculated for the specified model.
W.MN	Calculates the weighted mean of the *x*-values using the *y*-values as weights (or frequencies).
G.SD	Calculates the standard deviation of a set of numbers (*x*-values) occurring with the specified *integer* frequencies (*y*-values).
SIZE	Displays the number of items in each list.
	↓ MORE
ΣX	Calculates the sum (total) of the *x*-values.
ΣY	Calculates the sum (total) of the *y*-values.
ΣX2	Calculates the sum of the squares of the *x*-values.
ΣY2	Calculates the sum of the squares of the *y*-values.
ΣXY	Calculates the sum of the products of the *x*- and *y*-values.

* Calculated using the transformed equations for the exponential, logarithmic, and power models.

The HP-19B uses the x- and y-values to calculate B, M, and the correlation coefficient. The correlation coefficient measures how well the calculated curve describes your data. Once the curve has been calculated, it can be used to do forecasting (what if?) calculations.

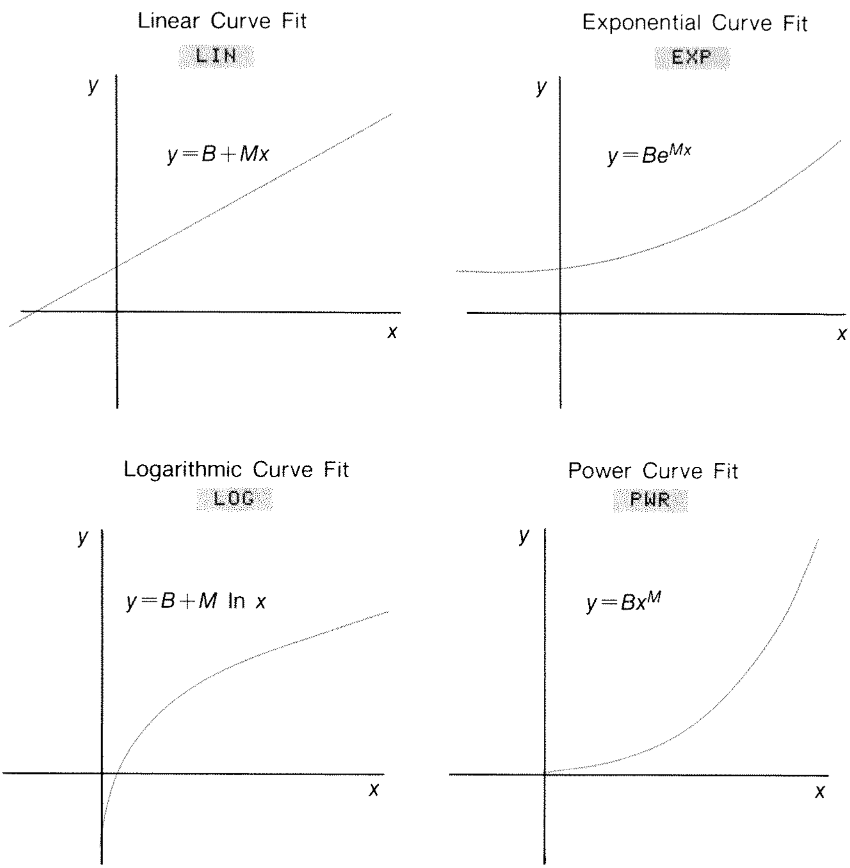


Figure 7-9. Curve Fitting Models

To do curve fitting and forecasting:

1. Prepare a SUM list for the x-values, and name the list.
2. Prepare a SUM list for the y-values. Naming this list is optional.
3. From the SUM menu (the y-list must be the current list) press CALC to display the CALC menu, then press MORE.
4. Press FRCST. The HP-19B displays a menu containing a label for each named SUM list in memory. If necessary, press MORE to see all the list names.
5. Press the menu key for the list containing the x-values. The HP-19B displays the model-selection menu.
6. Press the menu key for the model you want to use. The HP-19B displays the FRCST menu.
7. To display the curve fitting results, press CORR, M, and/or B (see table 7-3).
8. To do forecasting calculations:
    1. Key in a value and press the menu key for the known value— XLIST or YLIST.
    2. Press the menu key for the value you are forecasting.

Example: Curve Fitting. Bolden's Health Foods advertises on a local radio station. For the past six weeks, the manager has kept records of the number of minutes of advertising that were purchased, and the sales for that week:

	Number of Minutes of Radio Advertising Purchased (x-Values)	Dollar Sales (y-Values)
Week 1	2	$1,400
Week 2	1	$ 920
Week 3	3	$1,100
Week 4	5	$2,265
Week 5	5	$2,890
Week 6	4	$2,200

Part 1: Bolden's wants to determine whether there is a linear relationship between the amount of radio advertising purchased and the weekly sales.

Keys:	Display:	Description:
SUM *		Displays the SUM menu.
■ [CLEAR DATA]		Clears the list.
YES	▶ITEM(1)= TOTAL=0.00	
2 [INPUT] 1 [INPUT] 3 [INPUT] 5 [INPUT] 5 [INPUT] 4 [INPUT]	ITEM(6)=4.00 ▶ITEM(7)= TOTAL=20.00	Enters the number of minutes of advertising (x-values) into a SUM list.
NAME MINUTES [INPUT]	NAME IS NOW: ▶MINUTES	This message is briefly displayed.
GET *NEW	▶ITEM(1)= TOTAL=0.00	Switches to a new, empty list.
1400 [INPUT] 920 [INPUT] 1100 [INPUT] 2265 [INPUT] 2890 [INPUT] 2200 [INPUT]	ITEM(6)=2,200.00 ▶ITEM(7)= TOTAL=10,775.00	Enters the weekly sales (y-values) into a SUM list.
NAME SALES [INPUT]	NAME IS NOW: ▶SALES	The message is briefly displayed.

* If you want to preserve the current list, skip the next step (pressing ■ [CLEAR DATA]). Instead, name the list (see page 158), and then press GET *NEW .

CALC MORE FRCST MINU		Selects MINUTES as the x-list and displays the FRCST menu.
LIN		Selects the linear model.
CORR	CORR=0.90	Displays the correlation coefficient for the linear model.

Part 2: This correlation coefficient is acceptable to Bolden's. Using the linear model, estimate what the level of sales would be if Bolden's purchased 7 minutes of advertising time per week.

7 XLIST	XLIST=7.00	Stores 7 in variable XLIST.
YLIST	YLIST=3,357.38	Calculates the forecasted sales.

Plotting the Curve-Fitting Results

Pressing PLOT draws a graph of the x,y-data points and the calculated curve. The graph is automatically scaled to fit all the points on the display. To view the x,y-values of any position on the display, use the arrow keys ([←] [→] [↑] [↓]) to move the graphics cursor there.

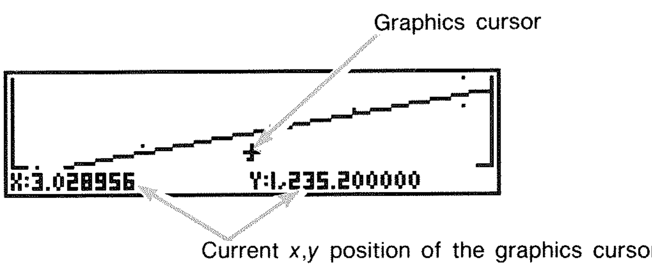


Figure 7-10. A Plot of Sales Versus Advertising Time for Bolden's Health Foods

To erase the plot and return to the FRCST menu, press [EXIT].

The graphics cursor provides an alternative to using the XLIST and YLIST keys to do forecasting calculations. By moving the graphics cursor along the plotted curve, you can view sets of x,y-values. However, the results are less accurate,* and you are limited to the portion of the curve shown on the display. To "extrapolate" beyond the plotted curve, you must use XLIST and YLIST (see page 168).

To store the currently displayed x,y-values for later use, press [INPUT]. The values are stored into the variables *XLIST* and *YLIST*.

To halt plotting before the graph is complete, press any key. If you halt plotting very quickly after you've pressed PLOT, the HP-19B displays the data points without the model.

Printing the Curve Fitting Plot. To print the plot, press [PRNT] while the plot is displayed.

Weighted Mean and Grouped Standard Deviation

The following procedure calculates the weighted mean and grouped standard deviation. The x-list contains the numeric data, and the y-list contains the weights (or frequencies) of each number. Weighted mean can use integer (whole-number) or non-integer weights. For grouped standard deviation, the y-list should contain integers only.

1. Enter the data values into a SUM list. Name the list.
2. Enter the corresponding weights or frequencies into another list. Naming this list is optional.
3. From the SUM menu (the list containing the weights/frequencies must be the current list), press CALC MORE FRCST.
4. Press the menu key for the list containing the data values to designate it the x-list.
5. Press any model key. The model is irrelevant in calculating weighted mean and grouped standard deviation.
6. Press MORE.
7. To calculate the weighted mean, press W.MN. To calculate the grouped standard deviation, press G.SD.

* The loss of accuracy is due to the limited resolution of the display.

Example: Weighted Mean. A survey of 266 one-bedroom rental apartments reveals that 54 of them rent for $200 per month, 32 for $205, 88 for $210, and 92 for $216. What is the average monthly rent and its standard deviation?

Keys:	Display:	Description:
SUM *		Displays the SUM menu.
■ [CLEAR DATA]		Clears the SUM list.
YES	▶ITEM(1)= TOTAL=0.00	
200 [INPUT] 205 [INPUT] 210 [INPUT] 216 [INPUT]	 ITEM(4)=216.00 ▶ITEM(5)= TOTAL=831.00	Stores rents into a list.
NAME RENT [INPUT]	 NAME IS NOW: ▶RENT	Names this list RENT.
GET *NEW	▶ITEM(1)= TOTAL=0.00	Gets a new, empty list.
54 [INPUT] 32 [INPUT] 88 [INPUT] 92 [INPUT]	 ITEM(4)=92.00 ▶ITEM(5)= TOTAL=266.00	Stores frequencies into second list.
CALC MORE FRCST RENT	 SELECT A MODEL	Specifies RENT as the x-list.
LIN	LINEAR	Select *any* model. (The model is irrelevant to this calculation.)

* If you want to preserve the current list, skip the next step (pressing ■ [CLEAR DATA]). Instead, name the list (refer to page 158), and then press GET *NEW .

MORE W.MN	209.44	Calculates the weighted mean—the average monthly rent.
G.SD	5.97	Calculates the standard deviation of the rents.

Summation Statistics

The summation values are of interest if you want to perform other statistical calculations besides those done in the CALC menu. To find Σx, Σx^2, Σy, Σy^2, $\Sigma(xy)$, and n, the number of elements in either list:

1. Prepare a list of the x-values and name the list.
2. Prepare a list of the y-values. Naming this list is optional.
3. With the y-list displayed, press CALC MORE FRCST .
4. Select the x-variable by pressing the appropriate menu key.
5. Select any model; the model choice is irrelevant.
6. To calculate n: press MORE SIZE . To calculate other summation values, press MORE again, then the appropriate menu key.

For calculations involving only one variable, the current, named list can be designated both the x- and y-variable (see the following example).

Example: Summation Statistics. Calculate Σx and Σx^2 for the following values of x: 2.34, 3.45, 4.56.

Keys:	Display:	Description:
SUM *		Displays the SUM menu.
■ [CLEAR DATA]		Clears the current list.
YES	▶ITEM(1)= TOTAL=0.00	

* If you want to preserve the current list, skip the next step (pressing ■ [CLEAR DATA]). Instead, name the list (refer to page 158), and then press GET *NEW .

2.34 [INPUT]
3.45 [INPUT]
4.56 [INPUT]
	`ITEM(3)=4.56`
	`▶ITEM(4)=`
	`TOTAL=10.35`
		Enters the data.

NAME X [INPUT]	`NAME IS NOW:` `▶X`	Names the list X.
CALC MORE FRCST	`SELECT X VARIABLE`	
X	`SELECT A MODEL`	Current list is both x- and y-variable.
LIN		Model is irrelevant.
MORE MORE ΣX	`ΣX=10.35`	Calculates total (same as previous *TOTAL*).
ΣX2	`ΣX2=38.17`	Calculates Σx^2.

Using SUM Lists With the Solver

The Solver provides the ability to do other statistical calculations with SUM lists. The Solver functions `ITEM` and `SIZES` use data stored in SUM lists. In addition, the "summing" function `Σ` lets you write equations that sum mathematical expressions containing list items. (See page 241).

8

Time, Appointments, and Date Arithmetic

Introduction

The HP-19B contains a clock and calendar, which are used by the TIME menu. You can select a 12- or 24-hour clock, and a month/day/year or day.month.year calendar format.* You can also:

- Store appointments that set alarms with optional messages.
- Determine the day of the week for a particular date.
- Calculate the number of days between two dates using the 360-day, 365-day, or actual calendar.

Viewing the Time and Date

To view the time, date, and day of the week, press TIME in the MAIN menu.

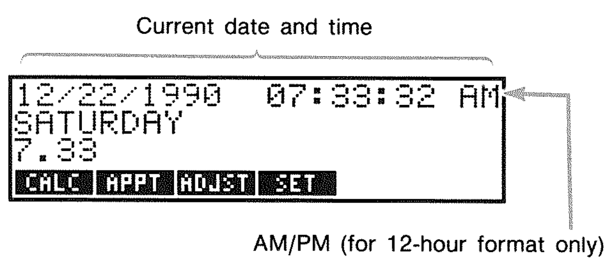


Figure 8-1. The TIME Menu and Display

* The HP-19B calendar runs from October 15, 1582 to December 31, 9999.

Table 8-1 describes the TIME menu keys.

Table 8-1. TIME Menu Keys

Menu Key	Description
CALC	Displays the CALC menu, which is used to calculate the number of days between two dates or the date a specified number of days before or after a given date; also used to determine the day of the week for any date.
APPT	Displays the APPT menu, used to set and view appointment alarms.
ADJST	Displays the ADJST menu for adjusting the clock setting.
SET	Displays the SET menu for setting the time and date; also selects the time and date formats.

Setting the Time and Date

The SET menu is used to set the time and date and to change the time and date formats. Table 8-2 describes the SET menu.

Setting the Time. To set the time, from the MAIN menu:

1. Press TIME, then SET to display the SET menu. Note the current time format—AM or PM after the time indicates 12-hour format.
2. Using the current format, key in the correct time* as a number in the form HH.MMSS. For example 9:08:30 PM would be keyed in as 9.0830 (12-hour format) or 21.0830 (24-hour format).
3. Press TIME. The clock is now set to the new time.
4. For 12-hour format only: If necessary, press A/PM to switch between AM and PM.

* To set the exact time from a time standard, key in an HH.MMSS value 15 to 30 seconds in the future. Press TIME when the two times match.

Setting the Date. To set the date:

1. Note the current date format. If the date contains slashes (for example, 10/23/1991), the current format is month/day/year. If the date contains periods (for example, 23.10.1991), the current format is day.month.year.
2. Key in the correct date as a seven- or eight-digit number, using the current format. For example, April 3, 1992 would be 4.031992 (MM.DDYYYY) in month/day/year format or 3.041992 (DD.MMYYYY) in day.month.year format.
3. Press DATE.

Table 8-2. SET Menu Keys

Menu Key	Description
DATE	Enters the number in the calculator line as the current date.
TIME	Enters the number in the calculator line as the current time.
A/PM	In 12-hour format, switches the clock setting between AM and PM.
M/D	Switches between month/day/year format and day.month.year format.
12/24	Switches between 12-hour and 24-hour time formats.
HELP	Displays the keystrokes for keying in the time and date.

Example: Setting the Date and Time. Set the date and time to June 9, 1990, 4:07 p.m.

Keys:	Displays:	Description:
TIME		Displays the current settings
SET		Displays the SET menu.
6.091990 DATE	06/09/1990 SATURDAY	Sets current date.

4.07 TIME A/PM *	04:07:xx PM	Sets current time.

Changing the Time and Date Formats

Use the SET menu to change the time and date formats (from the MAIN menu, press TIME, then SET). To switch between the 12- and 24-hour time format, press 12/24. To switch between month/day/year and day.month.year format, press M/D.

Adjusting the Clock Setting

The ADJST menu adjusts the time setting forward or backward in increments of hours, minutes, or seconds. To adjust the time setting, from the TIME menu:

1. Press ADJST.
2. Press the appropriate menu key(s) until the correct time is displayed. For example, if the current time setting is 11:20:*xx* AM (ignoring seconds), pressing +HR twice changes the time to 1:20 PM. Then, pressing -MIN three times changes the time to 1:17 PM.

Appointments

The HP-19B has six appointments. To set an appointment, you store the date and time that you want the appointment to go off, plus an optional message. You can also designate repeating appointments—appointments that go off at regular intervals.

* Press only if previous time setting was AM.

Viewing and Setting an Appointment

To set an appointment or view the current setting of an appointment, starting from the MAIN menu:

1. Press TIME, then APPT. The APPT menu contains a menu label for each of the six appointments. A message describes the status of the appointments.

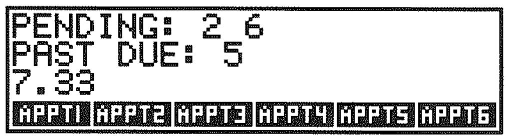


Figure 8-2. The APPT Menu and Appointment Status

Pending appointments are those set to some future time. *Past due* appointments are those that previously came due and have not been acknowledged. All other appointments are *expired;* they were acknowledged when they went off sometime in the past, or they have been cleared.

2. Press a menu key— APPT1 through APPT6. The display shows the current setting for that appointment and the appointment-setting menu described in table 8-3.

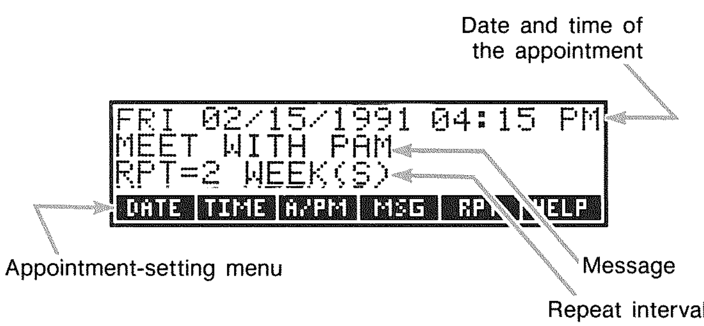


Figure 8-3. The Current Setting of an Appointment

Table 8-3. The Appointment-Setting Menu Keys

Menu Key	Description
DATE	Enters the number on the calculator line as the appointment date.
TIME	Enters the number on the calculator line as the appointment time.
A/PM	In 12-hour time mode, sets AM or PM.
MSG	Used to type an appointment message.
RPT	Displays the RPT (repeat) menu, which is used to set the repeat interval.
HELP	Displays the keystrokes for setting the appointment time and date.

3. Press ■ [CLEAR DATA] to clear the previous appointment settings.
4. If you are uncertain how to key in the time or date, press HELP .
5. **Setting the appointment time:** Note the time format in use—AM or PM after the time indicates 12-hour format. Key in the time of the appointment as a number in the form HH.MMSS. For example, 2:25 p.m. would be 2.25 (12-hour format) or 14.25 (24-hour format). Press TIME . If the date setting was a previous date (including 00/00/0000), the date is automatically set to the current date.

   For 12-hour format only: If necessary, press A/PM to switch between AM and PM.
6. **Setting the appointment date:** If necessary, key in the date of the appointment as a number, using the current date format. For example, October 4, 1988 would be 10.041988 (month/day/year format) or 4.101988 (day.month.year format). Press DATE . If you omit the year, the calculator assumes the current year.
7. **Messages:** If you want to store a message, press MSG . Type the message and press [INPUT]. Messages are limited to a maximum of 22 characters.

8. **Repeating appointments:** If you want the appointment to repeat at a particular interval, press RPT to display the RPT menu. Key in an integer and press the appropriate key. For example, 2 DAY sets the appointment to go off at the same time every other day; 90 MIN sets the repeat interval to 1½ hours. NONE restores the appointment to non-repeating. You can specify repeat intervals up to 104 weeks in length (728 days, 17,472 hours, etc.).
9. Press [EXIT] to return to the APPT menu. The appointment you just set will be listed as a pending appointment.

Acknowledging an Appointment

When an appointment "comes due," the HP-19B beeps and the appointment annunciator comes on.* If the appointment has a message, it is displayed on line 1; otherwise, the HP-19B displays the date and time of the appointment. If the calculator is turned off when an appointment comes due, it turns itself on to announce the appointment.

To acknowledge the appointment and clear the message, press any key while the HP-19B is beeping. Appointments not acknowledged within 20 seconds become past due.

Unacknowledged Appointments

If an appointment is not acknowledged within 20 seconds, the beeping stops and the appointment is classified as past due (unacknowledged). The appointment annunciator (((•))) remains on to inform you that you have a past due appointment.

* If the HP-19B is in the middle of a complex calculation when an appointment comes due, the appointment annunciator comes on and the calculator beeps once. When the calculation is done, the HP-19B displays the message and resumes beeping for 20 seconds.

The beeper does not sound in BEEPER OFF mode.

To acknowledge a past due appointment, from the MAIN menu:

1. Press TIME, then APPT. The display lists any past due appointments.
2. Press the menu key for the past due appointment.
3. Press [EXIT] to return to the APPT menu. Note that the acknowledged appointment is no longer listed as past due.

A repeating appointment is deactivated while it is past due. It will not go off at subsequent repeat intervals until the appointment has been acknowledged.

Clearing Appointments

Clearing an appointment sets its date and time to 00/00/0000, 12:00 AM, erases its message, and sets its repeat interval to NONE.

To clear a particular appointment, display the appointment-setting menu for the appointment and press ■ [CLEAR DATA].

To clear all six appointments, display the APPT menu (the menu showing the status of all six appointments) and press ■ [CLEAR DATA] YES.

Example: Setting and Clearing an Appointment. Today is Monday, April 15, 1991. You want to set an appointment to go off every Friday at 2:15 p.m. to remind you of a staff meeting. The example assumes 12-hour time format and month/day/year date format.

Keys:	Display:	Description:
TIME APPT		Displays the APPT menu.
APPT4		Displays the appointment-screen and menu for appointment #4.
■ [CLEAR DATA]	00/00/0000 12:00 AM	Clears the appointment.

2.15 TIME	MON 04/15/1991 02:15 AM	Stores the appointment time, current date.
A/PM	02:15 PM	Sets the appointment time to PM.
4.19 DATE	FRI 04/19/1991 02:15 PM	Stores the appointment date.
MSG STAFF MEETING		Enters the message.
INPUT	STAFF MEETING	
RPT		Displays the RPT (repeat) menu.
1 WEEK	RPT=1 WEEK(S)	Sets the repeat interval to one week.
EXIT	PENDING: 4	Displays the APPT menu; appointment #4 is listed as pending.

Date Arithmetic

The CALC menu is used to do date arithmetic—finding the number of days between two dates, or determining the date a given number of days in the future or past. Date arithmetic uses one of three calendars—actual, 365-day, or 360-day (refer to table 8-4). You can also use the CALC menu to determine the day of the week for any date.

To display the CALC menu, from the MAIN menu, press TIME, then CALC.

Table 8-4. The CALC Menu for Date Arithmetic

Menu Key	Description
DATE1 DATE2	Stores or calculates a date, using the current date format—month/day/year (MM.DDYYYY) or day.month.year (DD.MMYYYY); also displays the day of the week. If you omit YYYY, the calculator uses the current year.
DAYS	Stores or calculates the number of days between *DATE1* and *DATE2*, using the actual calendar. The actual calendar recognizes leap years.
360D	Calculates the number of days between *DATE1* and *DATE2*, using the 360-day calendar. The 360-day calendar is based on 30-day months.
365D	Calculates the number of days between *DATE1* and *DATE2*, using the 365-day calendar. The 365-day calendar ignores leap years.
TODAY	Displays the current date, which can then be stored in *DATE1* or *DATE2*.

Determining the Day of the Week for Any Date

To find the day of the week for any date, key in the date and press DATE1 or DATE2.

Calculating the Number of Days Between Dates

To calculate the number of days between two dates, starting from the CALC menu:

1. Key in the first date in the current date format and press DATE1.
2. Key in the second date and press DATE2.
3. Press DAYS, 360D, or 365D to calculate the number of days using that calendar.

Example: Calculating the Number of Days Between Two Dates. Find the number of days between April 20, 1949 and August 2, 1988, using both the actual calendar and the 365-day calendar. Assume the date format is month/day/year.

Keys:	Display:	Description:
TIME CALC		Displays the CALC menu.
4.201949 DATE1	DATE1=04/20/1949 WED	Stores the first date and displays day of the week.
8.021988 DATE2	DATE2=08/02/1988 TUE	Stores the second date.
DAYS	ACTUAL DAYS= 14,349.00	Calculates the number of days using the actual calendar.
365D	365 DAYS=14,339.00	Calculates the number of days using the 365-day calendar.

Determining Past or Future Dates

The HP-19B can determine the date a specified number of days from another date using the actual calendar. To calculate a date:

1. Key in the known date in the current date format and press DATE1.
2. Key in the number of days. If the unknown date precedes the known date, press +/-. Press DAYS.
3. Press DATE2.

Example: Determining a Future Date. On February 9, 1989, you purchase a 120-day option on a piece of land. Determine the expiration date. Assume the date format is month/day/year.

Keys:	Display:	Description:
TIME CALC		Displays the CALC menu.
2.091989 DATE1	DATE1=2/09/1989 THU	Stores DATE1.
120 DAYS	ACTUAL DAYS=120.00	Stores the number of days in the future.
DATE2	DATE2=6/09/1989 FRI	Calculates the expiration date.

Clearing the Date Arithmetic Variables

When the HP-19B is displaying the TIME CALC menu, pressing ■ [CLEAR DATA] clears *DATE1, DATE2* and *ACTUAL DAYS* to 0. The date arithmetic variables are also cleared when you switch menus.

9

Storing Text Information

Introduction

The TEXT menu lets you store lists of information—for example, names and addresses, family birthdays, and manufacturing parts lists. TEXT offers these features:

- Flexible organization. You can organize a list as individual entries, or you can group entries into sets called "records." Records can consist of as many entries as you like. Furthermore, records in a list can have varying numbers of entries.
- Easy viewing. You can move through a list entry by entry or record by record.
- Editing. You can edit individual entries, and add and delete entries and records. In addition, you can change the organization of a list—divide an existing list into records or merge records.
- Information retrieval. You can search for a particular sequence of characters.
- Sorting. You can sort lists alphabetically.

Organizing TEXT Information

Consider the following two lists of information:

Parts List

. . . . TOP . . . .
LOCKWASHER: 2133-457
SCREW: 0555-2740
BOTTOM CASE: 1938-4582
CAPACITOR (22 PF): 366-588
RESISTOR (1 OHM): 1883-4922

Address List

. . . . TOP . . . .
HONKER, HANK D.
9876 BARN PLACE
ALLSEE RIVER CITY, OR 97333
503-144-7788
. . . .
PURNA, ANNA
1234 MOUNTAIN VIEW DRIVE
CASCADES, OR 97331
. . . .
STAN'S GLASS CO.
8877 TULIP ST.
DEEREATEN, OR 97330
503-113-4466 (BEFORE 10 AM ONLY)

These two lists are organized differently. The parts list contains one entry per part; each entry contains both the name and part number. Notice that entries can vary in length; in fact, the length of an entry is limited only by available memory.

In the address list, information for each person consists of a group of three or four separate entries—name, address, city/state/zipcode, and phone number. Each group is called a *record*; each record ends with a *record marker* that separates it from the next record. The address list contains 2, 4-line records and 1, 3-line record (a 4th entry can be added later if you want to add Anna's phone number).

The TEXT menu lets you use the same organization in your lists. Deciding ahead of time how you want your information organized helps you use TEXT lists effectively.

The TEXT Menu

To display the TEXT menu, press TEXT in the MAIN menu. If you haven't previously used the TEXT menu, the HP-19B displays an empty TEXT list. The list pointer and flashing cursor in line 3 indicate that you are ready to start adding information to the list.

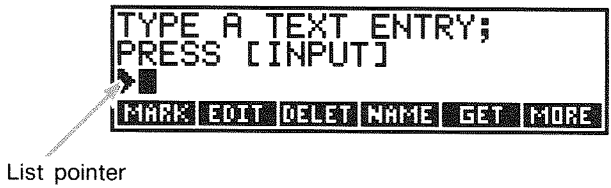


Figure 9-1. An Empty TEXT List

Table 9-1 describes the TEXT menu.

Table 9-1. TEXT Menu Keys

Menu Key	Description
MARK	Inserts a *record marker* after the current entry.
EDIT	Allows you to edit an entry after it has been entered; also allows you to view entries longer than 22 characters.
DELET	Deletes the current entry.
NAME	Names the list.
GET	Switches from one list to another or creates a new TEXT list.
	↓ MORE ↑
FIND	Searches for a sequence of characters.
EDIT	Duplicate of EDIT in the first page of the menu.
PREV	Moves the pointer beneath the previous record marker.
NEXT	Moves the pointer beneath the next record marker.
SORT	Sorts the list alphabetically.

If you have previously used the TEXT menu, the HP-19B displays the TEXT list you worked with most recently. The list pointer is in line 2, positioned at the entry it was at when you last used the list. To see more of the list, press [↑], [↓], PREV, or NEXT.

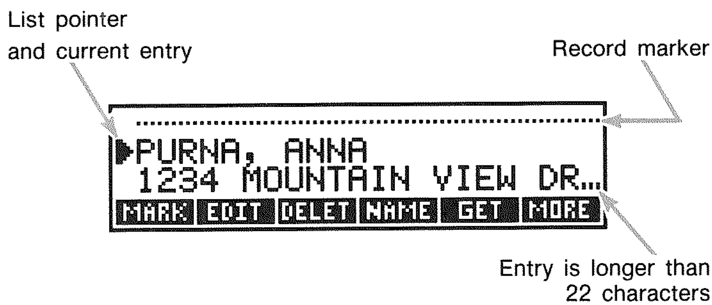


Figure 9-2. A TEXT List That Contains Information

To display an empty list, you can:

- Clear the list by pressing [CLEAR DATA] YES. (See page 198 for more information.)
- Create a new list by pressing GET, then *NEW. (See page 198 for more information.)

Entering TEXT Information

To enter text into an empty list:

1. Type the first entry. If it is longer than 22 characters, the first line rolls up to make room for another line of characters. If you make a typing mistake, you can correct it using the alphabetic editing keys.

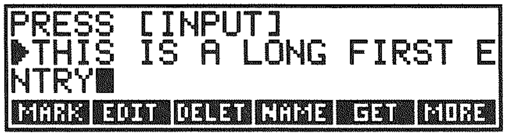


Figure 9-3. Typing an Entry Longer Than 22 Characters

You can insert spaces to keep a word together on one line.

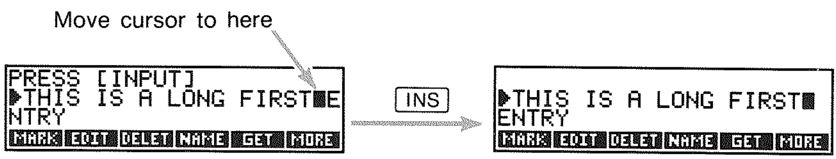


Figure 9-4. Formatting Text With Spaces

2. Press [INPUT] to store the entry. If the entry is longer than 22 characters, only the first 21 characters are shown.

Figure 9-5. Storing the First Entry

3. Continue storing entries by typing them and pressing [INPUT].

Entering Record Markers. A record marker is a special entry that designates the end of a record. When the last entry in a record has been stored, press MARK to enter a record marker beneath it (see figure 9-6). Each record *must* have at least one entry. In other words, you cannot store two adjacent record markers.

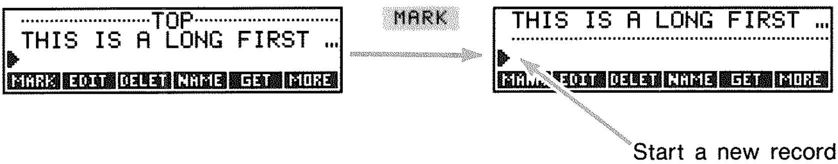


Figure 9-6. Storing a Record Marker

Viewing the TEXT List

Moving the List Pointer

Moving the Pointer One Entry at a Time. The [↑] and [↓] keys move the list pointer up and down the list one entry at a time. [↑] displays the top-of-list marker. As you move through the list, the pointer is positioned in line 2, allowing you to see the entries above and below the current entry. [↓] moves the list pointer to the bottom of the list, allowing you to add additional entries.

Moving the Pointer Between Records. When a list is divided into records, PREV and NEXT finds the previous or next record marker and positions the pointer beneath it.

Viewing Long Entries

The TEXT list shows only the first 21 characters of long entries. To view the entire current entry, press EDIT . If the entry is more than three lines long, use [↓] to see the rest of the entry. When you are done reading the entry, press [EXIT].

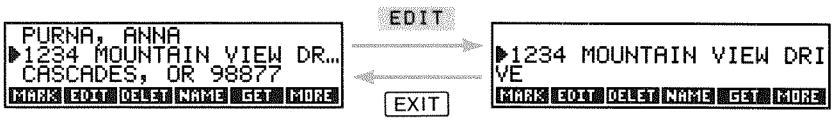


Figure 9-7. Reading a Long Entry

Editing a TEXT List

Editing an Entry. To edit the current entry, press EDIT to display the entire entry and cursor. Make the necessary changes (you can use all the alphabetic editing keys) and press [INPUT].

To abort an editing operation before pressing [INPUT] (thereby retaining the previous version of the entry), press [EXIT].

Inserting an Entry. An inserted entry is placed beneath the current entry. To insert an entry, position the list pointer at the entry that will be above the new entry. Type the new entry and press [INPUT].

Deleting an Entry. To delete the current entry, press DELET . When you've deleted all the entries in a record, the record marker is automatically deleted.

Inserting a Record Marker. To insert a record marker into an existing list, position the list pointer at the entry that will be the last one in the record and press MARK .

Deleting a Record Marker. To delete a record marker (thereby merging two adjacent records), position the list pointer at the marker and press DELET.

Example: An Address List. Create an address list with two records—one for Hank D. Honker and the other for Stan's Glass Co.

Keys:	Display:
TEXT *	
■ [CLEAR DATA] YES	▶
HONKER, HANK D. [INPUT]	.... TOP .... HONKER, HANK D. ▶
9876 BARN PLACE [INPUT]	HONKER, HANK D. 9876 BARN PLACE ▶
ALLSEE RIVER CITY, OR 97333 [INPUT] 503-144-7788 [INPUT]	ALLSEE RIVER CITY, OR… 503-144-7788 ▶
MARK	503-144-7788 .... ▶
STAN'S GLASS CO. [INPUT] 8877 TULIP ST. [INPUT] DEEREATEN, OR 97330 [INPUT]	8877 TULIP ST. DEEREATEN, OR 97330 ▶

Do not press [INPUT] after you've typed the next entry:

503-113-4466 (BEFORE 10 AM ONLY)	DEEREATEN, OR 97330 ▶503-113-4466 (BEFORE 1 0 AM ONLY)

* If the current list already contains information, you can preserve it by skipping the next step. Instead, name the current list (see page 197) and then press GET *NEW.

For better readability, you can move the rightmost 1 to the next line. Use [↑] and [→] to position the cursor before the 1, then:

[INS]	DEEREATEN, OR 97330 ▶503-113-4466 (BEFORE 10 AM ONLY)
[INPUT]	DEEREATEN, OR 97330 503-113-4466 (BEFORE… ▶

To view the information for Hank:

MORE PREV PREV	.... TOP .... ▶HONKER, HANK D. 9876 BARN PLACE

To see Hank's zip code:

[↓] [↓] EDIT	▶ALLSEE RIVER CITY, OR 97333
EXIT	▶ALLSEE RIVER CITY, OR…

To insert the record for Anna Purna between the records for Hank and Stan, move the pointer to the record marker separating the two records. Type the new record:

NEXT [↑]	503-144-7788 ▶ .... STAN'S GLASS CO.
PURNA, ANNA [INPUT]	.... ▶PURNA, ANNA STAN'S GLASS CO.
1234 MOUNTAIN VIEW DRIVE [INPUT] CASCADES, OR 97331 [INPUT]	1234 MOUNTAIN VIEW DR. ▶CASCADES, OR 97331 STAN'S GLASS CO.
MORE MARK	CASCADES, OR 97331 ▶ .... STAN'S GLASS CO.

Searching for Information

The FIND key lets you move the list pointer to an entry containing a specified sequence of characters. You can search for any sequence up to 8 characters long—for example, ALLSEE, TULIP ST, or 503-144.

A search starts at the entry beneath the current entry. If no match is found, the search stops at the bottom of the list, and the pointer moves to the top-of-list marker.

To search the current list:

1. Press FIND. If you've previously searched the list, the edit line displays those characters.
2. Type the sequence of characters or edit the existing contents of the edit line. If the edit line contains more than eight characters, the extra characters are ignored.
3. Press [INPUT].
   - If a match is found, the search halts at the entry containing the match. If necessary, press EDIT to see the entire entry, then [EXIT].
   - If no match is found between the starting entry and the end of the list, the HP-19B displays the top-of-list marker.
4. To continue searching for the same characters, press [INPUT].

Sorting a TEXT List

SORT sorts the current list alphabetically. If the list is divided into records, the sort is based on the first entry of each record, and the entire record moves to its new position in the list.

If the list is not divided into records, all the entries are included in the sort.

The characters have the following sorting order:

space	0	1	2	3	4	5	6	7	8	9	A	ä	Å
	Ä	Æ	B	C	Ç	D	E	F	G	H	I	J	K	L
	M	N	Ñ	O	Ö	Ø	P	Q	R	S	T	U	ü	V
	W	X	Y	Z	(	)	[	]	{	}	<	>	=	+
	–	×	÷	■	%	*	.	,	;	:	¿	?	!	/
	@	&	#	$	£	"	'	^	~	Σ	∡			

Naming and Renaming a TEXT List

A new TEXT list has no name. Naming the list helps you to locate it later, and lets you have more than one TEXT list in memory. A TEXT list can remain nameless until you want to display (GET) a different TEXT list.

Naming a List. To name a list, press NAME . Type the name and press [INPUT]. The first three to five characters (some letters are wider than others) become a menu label when you press GET to switch lists.

Viewing the Name of the Current List. Press NAME to display the list name, then [EXIT] to return to the TEXT menu.

Renaming a List. To change the name of the current list, press NAME . Edit the current name and press [INPUT].

Switching TEXT Lists and Creating New Lists

When you press TEXT, the current list is the TEXT list you used most recently.

To switch to a different list or create a new list:

1. If you haven't already done so, name the current list.
2. Press GET. The GET menu contains a menu label for each named list, plus *NEW.*
3. Press the appropriate menu key. *NEW displays a new, empty list.

Clearing a TEXT List

Clearing a TEXT list erases all the information in the list. The memory used by the list becomes available for other information.

To clear the current TEXT list, press ■ [CLEAR DATA], then YES. If the list is named, the HP-19B lets you choose whether or not to delete the name.

* If the HP-19B displays INSUFFICIENT MEMORY when you press GET, read the explanation of that message on page 338.

10

Printing

Introduction

The calculator can print information using the HP 82240 Infrared Printer, which accepts the infrared signal from the printer port. This chapter describes information you can print. Operation of the printer is covered in the printer owner's manual.*

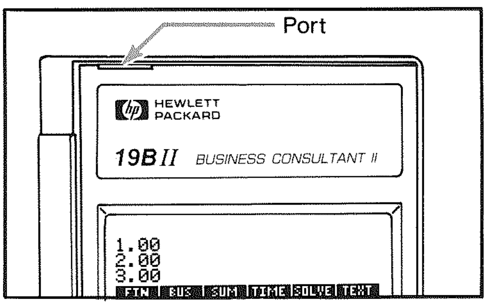


Figure 10-1. The Printer Port

The print annunciator (🖨) comes on whenever the calculator sends information through its printer port.

Because communication goes only one way—from calculator to printer—the calculator cannot determine whether the printer is receiving information. If a printing operation involves many lines of information, the calculator slows its transmission rate to allow the printer time to print.

* Since the HP-19B does not provide the ability to send control characters to the printer, portions of the printer's manual pertaining to control codes and graphics characters do not apply.

The Printer's Power Source

The speed of the printer depends on whether it is using its optional ac adapter. To optimize printing performance, set the printing-speed mode in the calculator appropriately. To view or change the printing-speed mode:

1. Press ▒ [MODES]. A message indicates the current mode:
   - PRINTER: AC ADAPTER
   - PRINTER: NO AC ADAPTER
2. Press PRNTR to change the mode.
3. Press [EXIT].

For long printing operations, printing is faster using the printer's ac adapter and the calculator's appropriate printing-speed mode. When the printer is powered by batteries alone, use PRINTER: NO AC ADAPTER so that the calculator will not transmit data too rapidly.

Printing the Calculator Line ([PRNT])

Press [PRNT] to print the rightmost number in the calculator line. If the calculator is in alpha mode, the entire contents of line 3 are printed. [PRNT] also prints the entire current equation (when the HP-19B is displaying the SOLVE menu) and graphics displays.

Printing Other Information (▒ [PRINTER])

The PRINTER menu, displayed by pressing ▒ [PRINTER], provides the ability to print most of the information you've entered. You can press ▒ [PRINTER] within almost any menu. In addition to printing specific information, you can produce a record of your calculations and other keystrokes (tracing).

Table 10-1. The PRINTER Menu

Menu Key	Description
DISPL	Prints the first three lines of the display.
LIST	Prints data stored or calculated in the current menu. See "Printing Variables, Lists, and Appointments" below.
REGS	Prints the contents of registers 0 through 9.
TIME	Prints the current date and time.
DBL	Turns double spacing off or on.
TRACE	Switches between Trace On and Trace Off modes. See "Trace Printing," page 202.

Pressing any of these keys except TRACE automatically displays the previous menu.

Printing Variables, Lists, and Appointments

The information printed by LIST varies from menu to menu.

Printing Variables. When a menu consists of variables, ■ [PRINTER] LIST prints those variables. For example:

- In the %CHG menu—*OLD, NEW,* and *%CH.*
- In the TVM menu—*N, I%YR, PV, PMT, FV, P/YR,* and the Begin/End mode.
- In the CFLO CALC menu—*TOTAL, I%, NPV, NUS,* and *NFV.**
- In a menu of Solver variables, those variables are printed.

* To print *IRR%*, press IRR% [PRNT].

Printing SUM, CFLO, and TEXT Lists. To print out the contents of the current list, display the SUM, CFLO, or TEXT menu and press ▒[PRINTER] LIST.

Printing Solver Equations. To print one or all of the Solver equations, display the SOLVE menu (press SOLVE). Then:

- To print the current equation, press [PRNT].
- To print the entire list of equations, press ▒[PRINTER] LIST.

Printing Appointments. To print all stored appointments, display the APPT menu (press APPT), then press ▒[PRINTER] LIST.

Menus Not Associated With Stored Data. Many menus do *not* have stored information associated with them. Pressing ▒[PRINTER] LIST while viewing these menus prints no information. For example, the MAIN, FIN, and BUS menus have no stored data. Similarly, menus such as the GET menus in the list menus, and the TIME SET menu are activity-oriented menus, and no information is printed.

Trace Printing

Trace printing produces a record of all the keys you've pressed and any calculated results. The calculator uses more power and operates more slowly when tracing is on.

To switch trace printing on and off:

1. Press ▒[PRINTER].
2. Press TRACE to change the setting. A message informs you that tracing is on or off. If necessary, press TRACE again to display the desired message.
3. Press [EXIT].

Example: Trace-Printing an Arithmetic Calculation. Produce a record of the keystrokes you use to do the following calculation and store the result in the TVM variable *PMT.*

$$\frac{1}{12} \times 4{,}800 + 125$$

Starting from the MAIN menu with tracing off:

Keys:	Print-out:	
■ [PRINTER] TRACE *		
[EXIT]		EXIT
FIN		FIN
TVM		TVM
12 ■ [1/x]	12.00	1/X
	0.08	***
[×]		×
4800 [+]	4,800.00	+
125 [=]	125.00	=
	525.00	***
PMT		PMT
■ [PRINTER]		PRINTER
TRACE		TRACE
[EXIT]		

Printing Descriptive Notes

You may want to include a descriptive note in your printed information. To print a descriptive phrase, type in the characters and press [PRNT]. For example, typing SEPTEMBER BALANCE [PRNT] prints SEPTEMBER BALANCE on a line by itself.

* If the calculator displays PRINT MODE: TRACE OFF, press TRACE again.

Printing a Copy of the Display

To print a copy of the display, including any menu labels, hold down [ON] and press [PRNT]. Printing starts when you release both keys.

Printing an Amortization Table

To print an amortization table:

1. Enter the loan information, using steps 1 through 8 on page 86.
2. Press AMRT .
3. If you wish to start the table anywhere other than at payment #1, amortize all the previous payments using step 10 on page 86.
4. Key in the number of payments per table entry and press #P .
5. Press TABLE .
6. Key in the last payment to be printed and press START .

Example: Printing an Amortization Table. To purchase your new home, you have taken out a 30-year, $65,000 mortgage at 12.5% annual interest. Your monthly payment is $693.72. Print an amortization table with entries for the fifth and sixth years.

Keys:	Display:	Description:
FIN TVM		Displays the TVM menu.
■ [CLEAR DATA]	0.00	Clears the history stack and the TVM variables.
12.5 I%YR	I%YR=12.50	Stores the annual interest.
65000 PV	PV=65,000.00	Stores the amount of the loan.

693.72 [+/-] PMT	PMT=-693.72	Stores the monthly payment.
OTHER		Displays the secondary TVM menu.
■ [CLEAR ALL]	12 PMTS/YR: END MODE	Sets 12 payments per year, End mode.
AMRT		Displays the AMRT menu.
48 #P	PAYMENTS: 1-48 BALANCE=63,970.71 INTEREST=-32,269.27	Calculates the amortization schedule for the first 4 years.
12 #P	PAYMENTS: 49-60 BALANCE=63,622.94 INTEREST=-7,976.87	Calculates the amortization schedule for the fifth year.
TABLE 72 START		Prints amortization table with two entries for payments 49–60 and 61–72.

```
I%YR=               12.50
PV=             65,000.00
PMT=              -693.72
#PMTS/YR=           12.00
END MODE

PAYMENTS:49 - 60
INTEREST=       -7,976.87
PRINCIPAL=        -347.77
BALANCE=        63,622.94

PAYMENTS:61 - 72
INTEREST=       -7,930.82
PRINCIPAL=        -393.82
BALANCE=        63,229.12
```

Figure 10-2. An Amortization Table.

How to Interrupt the Printer

Pressing a calculator key during a long printing operation will interrupt transmission, but not immediately stop the printing. To stop the printer immediately, turn the printer off.

Part 2

The Solver

11

Using the Solver

Introduction

The Solver (the SOLVE menu) creates menus of variables from equations you enter and uses those menus to do calculations. Enter Solver equations in algebraic form regardless of the calculation mode (ALG or RPN). For example, suppose you frequently buy carpet and must calculate how much it will cost. The price is quoted to you per square yard. Regardless of how you are doing the calculation (even if you are doing it longhand), you are using an equation.

Price per sqare yard — Length (feet) — Width (feet)

$$\frac{PPSY \times L \times W}{\underset{\text{Converts square feet to square yards}}{9}} = COST$$

The SOLVE menu lets you type in this equation. When you press CALC, the Solver creates a menu of variables for doing the calculation. Figure 11-1 illustrates the menu of variables created from the "carpet" equation. You can store numbers into these variables and do calculations the same way you use built-in menus and their variables.

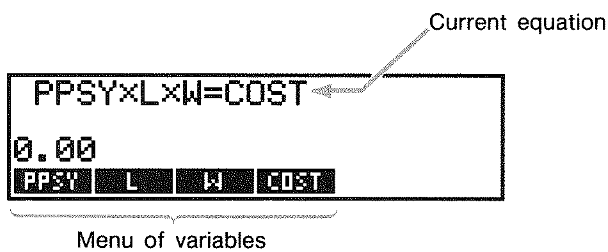


Figure 11-1. A Menu of Variables

Example: Entering an Equation and Using Its Menu of Variables. Part 1: Use the equation on page 208 to create the menu shown in figure 11-1. Then, calculate the cost of carpet needed to cover a 9′ by 12′ room. The carpet costs $22.50 per square yard.

Keys:	Display:	Description:
SOLVE ■ [↓]	▶	Displays the SOLVE menu and bottom of the equation list.
PPSY × L × W ÷ 9 = COST	▶PPSY×L×W÷9=COST	Types the equation into calculator line.*
CALC		Enters the equation and displays the menu of variables.
22.5 PPSY	PPSY=22.50	Stores the price per square yard in *PPSY*.
9 W	W=9.00	Stores the width.
12 L	L=12.00	Stores the length.
COST	COST=270.00	Calculates the cost.

Part 2: Determine the most expensive carpet you can buy if the maximum amount you can pay to carpet the room is $300.

300 COST	COST=300.00	Stores $300 in *COST*.
PPSY	PPSY=25.00	Calculates the maximum price per square yard you can pay.

* You must use the multiplication key ([×]), and not the alphabetic [X] key, to enter the "times" sign.

The SOLVE Menu and Equation List

Equations are stored in the Solver's *equation list*. To display the SOLVE menu and equation list, press SOLVE (in the MAIN menu.) If you haven't previously used the SOLVE menu, the equation list is empty and line 3 is ready to accept the equation you type.

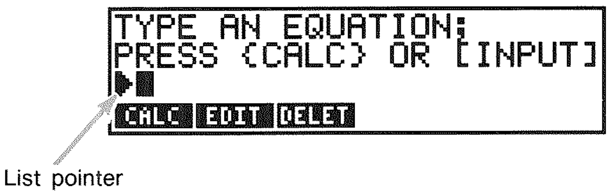


Figure 11-2. The Empty Equation List

If the equation list already contains one or more equations, the display will look different (see figure 11-3). The HP-19B displays a portion of the equation list. The list pointer points to the *current equation*—the equation the Solver uses to create the menu of variables when you press CALC . Lines 1 and 2 display the two equations that precede the current equation. You can use [↑] or [↓] to designate a different current equation.

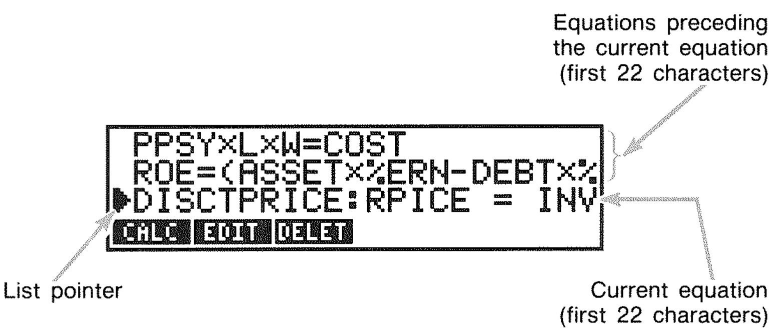


Figure 11-3. The Equation List With Several Stored Equations

The SOLVE menu shows the operations you can do with the current equation.

Table 11-1. SOLVE Menu Keys

Menu Key	Description
CALC	Displays the menu of variables for the current equation.
EDIT	Allows you to change an equation after it has been entered; also allows you to view an entire equation that is longer than 22 characters.
DELET	Displays the DELET menu, which is used to delete the current equation and/or its variables.

Entering Equations

The equation list can contain as many equations as you'd like, limited only by the amount of unused calculator memory.

To enter an equation, starting from the MAIN menu:

1. Press SOLVE.
2. If the list is empty, go to step 3. If the list already contains one or more equations, press ■ [↓] * to move the list pointer to the bottom of the equation list.
3. Type the equation. There is no limit on the length of the equation. When a line is full, it rolls up to make room for another line of characters. If you make a typing mistake, correct it using the alphabetic editing keys.
4. Do **a** or **b**:
   - **a.** Press CALC to enter the equation and display the menu of variables. Line 1 displays the first 22 characters of the equation.
   - **b.** Press [INPUT]. The cursor disappears and line 3 displays the list pointer and the first 22 characters of the equation. If you want to enter another equation, return to step 3.

* If you skip this step, the new equation is inserted after the current equation.

When you press [INPUT] or CALC, the HP-19B displays:

VERIFYING EQUATION...

to indicate that the Solver is checking the equation. If the equation cannot be interpreted, the HP-19B briefly displays:

INVALID EQUATION

and the cursor is positioned before the first character the Solver could not interpret. Check to be sure you've made no typing mistakes, and that you've followed the rules for writing equations in chapter 12.

Calculations With Solver Variables

Pressing CALC displays the menu of variables for the current equation. If the equation contains more than six variables, the Solver creates the label MORE to switch between sets of menu labels.

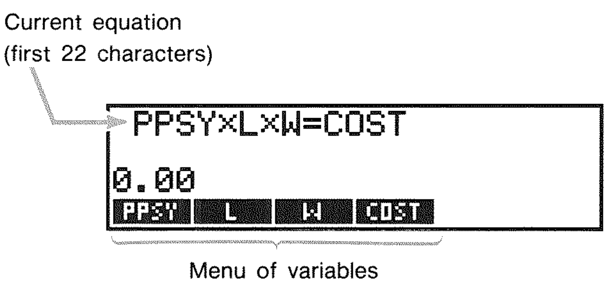


Figure 11-4. A Menu of Variables

To do a calculation using the menu of variables:

1. Store a value in all but one of the variables. For example, in using the menu in figure 11-4, you can store values in *PPSY*, *L*, and *W* to calculate *COST*. Or, you can store values in *PPSY*, *W*, and *COST* to calculate *L*. To store a value, key in the number and press the appropriate menu key. For example, 22.50 PPSY stores 22.50 in *PPSY*.

2. To start the calculation, press the menu key for the value you want to calculate. If the Solver is able to find a solution to the equation, the answer is displayed on the calculator line.

In most cases, this is all you will need to know about how the Solver works. However, there are certain types of equations that are more difficult to solve. If, during the calculation, the display temporarily shows sets of changing numbers, such as:

```
A:1.50000000000      -
A:1.13476129834      +
```

the Solver is searching for a solution. You should read "How the Solver Works" starting on page 219.

Example: Return on Equity. The Return on Equity of a business can be defined as:

$$ROE = \frac{Operating\ income - Interest - Taxes}{Common\ equity}$$

Operating income = assets × percentage earnings on assets
= ASSET×%ERN

Interest = debt × percentage interest paid on debt
= DEBT×%INT

Common equity = amount of common equity used for financing
= EQTY

The Solver equation would be:

```
ROE=(ASSET×%ERN÷100-DEBT×%INT÷100-TAX)÷EQTY×100
```

Find the ROE of a small firm with $2,000 in assets. The assets earned 10%, while its debt cost it 8%. The assets were financed using $500 of common equity and $1,500 of debt. The firm paid no taxes.

Keys:	Display:	Description:
SOLVE ■ [↓]	▶	Displays the SOLVE menu and bottom of the equation list.

Type the *ROE* equation. Then:

CALC		Enters the equation and displays the menu of variables.
2000 ASSET	ASSET=2,000.00	Stores the value of the assets.
10 %ERN	%ERN=10.00	Stores the percentage earnings on assets.
1500 DEBT	DEBT=1,500.00	Stores the debt.
8 %INT	%INT=8.00	Stores the percentage interest paid on debt.
MORE 0 TAX	TAX=0.00	Stores the taxes paid.
500 EQTY	EQTY=500.00	Stores the common equity.
MORE ROE	ROE=16.00	Calculates the return on equity.

Clearing Solver Variables

Clearing Solver variables sets them equal to 0. To clear the variables in a particular menu of variables, display the menu and press ■ [CLEAR DATA].

Viewing Long Equations

The equation list shows only the first 22 characters of an equation. To view the entire current equation, press EDIT (see figure 11-5). If the equation is longer than 68 characters, use [↓] to see the rest of the equation. When you are done viewing the equation, press [EXIT].

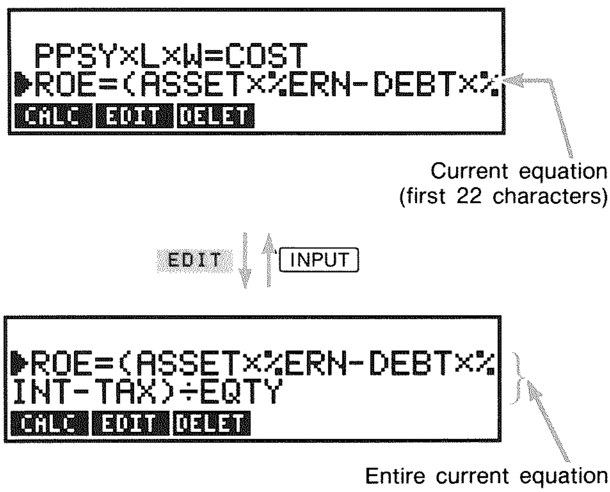


Figure 11-5. Viewing the Entire Current Equation

Editing an Equation

To change the current equation:

1. Press EDIT .
2. Make the necessary changes. You can use all the alphabetic editing keys (refer to table 1-1 on page 27).
3. Press [INPUT] or CALC to replace the previous version with the edited version.

Editing an equation clears its variables.

To abort an editing operation after you've pressed **EDIT**, press [EXIT].

Naming an Equation

Naming equations helps you identify them later. Figure 11-6 shows an equation list containing two named equations and one unnamed equation. The name precedes the equation; a colon separates the name from the beginning of the equation.

Figure 11-6. Equation Names

To name an equation, type in the name at the beginning of the equation. Separate the name from the equation with a colon (:). For example, to enter the equation PRICE=INVOICE×DISCOUNT, and name it DISCTPRICE, type:

```
DISCTPRICE:PRICE=INVOICE×DISCOUNT
```

If you type in an equation without a name, you can add a name later using the **EDIT** key.

Names can be any length and can include any characters except +, −, ×, ÷,), (, <, >, ^, :, =, and space.

Shared Solver Variables

If two or more equations contain the same variable, that variable is *shared* among the equations in which it appears. For example, suppose your equation list includes these two equations named CARPETPRICE and TOTALPRICE:

```
CARPETPRICE:PPSY×L×W÷9=COST

TOTALPRICE:COST+HOURS×20.50=CHARGE
```

COST is a shared variable. You can calculate a value for *COST* using the menu of variables for CARPETPRICE, and then switch to the menu for TOTALPRICE. Since the value for *COST* is shared, you do not need to store it again. After entering *HOURS*, you can calculate *CHARGE*.

No sharing occurs between built-in variables and Solver variables. For example, the *COST* user-variable in the Solver is not shared with the *COST* built-in variable in the MU%C and MU%P menus.

Deleting the Current Equation and/or Its Variables

Each equation in the equation list uses calculator memory to store the equation and its variables. For example, the equation:

```
PPSY×L×W÷9=COST
```

uses five storage locations. One location stores the equation; four locations store the user-variables *PPSY*, *L*, *W*, and *COST*. Deleting the variables frees the storage locations used to store *PPSY*, *L*, *W*, and *COST*. Deleting both the variables and the equation frees all five locations.

To delete the variables, or both the variables and the equation:

1. Press DELET to display the DELET menu.

2. Do **a** or **b**:

a. Press VARS to delete the variables associated with the current equation. The variables are created again the next time you use the equation. If the variable is a shared variable, its value is lost to all the equations that share it.

b. Press BOTH to delete the current equation and its variables.

Deleting All Equations and/or Their Variables

To delete the variables in *all* the equations, or to delete all the equations and their variables:

1. Display the SOLVE menu and press ■ [CLEAR DATA].

2. Do **a** or **b**:

a. To delete all the Solver variables, press VARS .

b. To delete all the Solver variables *and* all the equations, press BOTH .

Summary of Clear and Delete Operations

Table 11-2 summarizes the various ways to clear and delete information that is stored using the Solver.

Table 11-2. Summary of Clear and Delete Operations

To do this:	Display this menu:	And press:
Clear (set to 0) the variables in the current equation	Menu of variables for the equation (by pressing CALC)	■ [CLEAR DATA]
Delete the variables in the current equation	SOLVE	DELET VARS
Delete both the current equation and its variables	SOLVE	DELET BOTH
Delete all the Solver variables	SOLVE	■ [CLEAR DATA] VARS
Delete all the Solver equations and all Solver variables	SOLVE	■ [CLEAR DATA] BOTH

How the Solver Works

The Solver has two ways of finding an answer—*direct* solutions and *iterative* solutions.

Direct Solutions. Initially, the Solver tries to find a *direct* solution by rearranging the equation and then solving for the variable. If the Solver finds a direct solution, the HP-19B displays the answer on the calculator line, and no other information is displayed.

Iterative Solutions. If the Solver is unable to find a direct solution, the Solver tries to find an *iterative* solution. (*Iterative* refers to the repetitive numerical procedures used.) This involves searching for the answer by estimating a set of answers, seeing how close they are to a solution, and then making another set of estimates. The HP-19B displays the current estimates while the Solver is searching for an answer iteratively. You should keep in mind that *there may be more than one solution to an equation*, and that it may be necessary for you to enter guesses in order to influence which solution the Solver finds.

If the displayed estimates don't appear to be proceeding towards a number you judge to be a reasonable answer, you may want to stop the iterative process, enter your own guesses, and restart the search (refer to "Halting and Restarting the Iterative Search" and "Entering Guesses" on page 221).

Since the process of finding an iterative solution is very complex, there are four possible outcomes that you should be aware of. If necessary, refer to "Solver Calculations" on page 288 for additional descriptions of these possible outcomes.

- **Case 1:** The HP-19B displays an answer on line 3 and there is no message in lines 1 and 2. It is very likely that the Solver has found a solution. The HP-19B may display additional information if you repeat the calculation by pressing the menu key for the variable you solved for. If repeating the calculation causes the HP-19B to display a message in lines 1 and 2, you can read portions of "Solver Calculations" on page 288 to explain the meaning of the message.
- **Case 2:** The HP-19B displays an answer in line 3 and automatically displays a message in lines 1 and 2. The Solver has found a possible solution, but you must use judgement in interpreting the results (see "Solver Calculations" on page 288).
- **Case 3:** The HP-19B displays `TRY AGAIN, BAD GUESSES:` and the guesses the Solver used when the calculation was started (or restarted). This indicates that the Solver cannot begin the search with the current guesses. (See "Entering Guesses" on page 221.)
- **Case 4:** The HP-19B displays `SOLUTION NOT FOUND` because the Solver was unable to find a solution. Check to see if your equation and stored values are correct. If the equation is correct, you may be able to find a solution by entering very good guesses.

Halting and Restarting an Iterative Search

When the Solver is searching for an iterative solution (in other words, when the Solver is displaying sets of estimates), you can halt the calculation by pressing any key. The HP-19B displays the best estimate the Solver has found so far, and the message INTERRUPTED. You can restart the search from where it left off by pressing the menu key for the variable you are solving for. Or, you can restart the search using your own guesses (see "Entering Guesses," below).

Entering Guesses

Entering your own guesses serves two purposes. First, it can save time by telling the Solver where to start searching. Second, if more than one solution exists, entering guesses can help the Solver select the answer you want. The closer your guesses are to the answer you want, the better chance the Solver has of finding it.

You can enter guesses at these times:

- Before beginning the calculation, after you've stored a value for every variable except the unknown variable.
- After you've halted the iterative search.
- After the Solver has returned an answer, and you wish to begin searching for another answer somewhere else.

You can enter one or two guesses. If you enter one guess, the Solver makes a second guess. If you enter two guesses, the Solver starts searching for a solution in the range between the two guesses. The Solver works most efficiently when the answer is between your two guesses. For example, if you know the answer is between 5 and 12, you should enter 5 and 12 as the starting guesses.

To enter one guess, key in the value and press the menu key twice. For example, 4.5 A A enters 4.5 as a guess for a variable named *A* and starts the calculation.

To enter two guesses:

1. Key in the first guess and press the menu key.

2. Key in the second guess and press the menu key twice.

For example 0 A 100 A A causes the Solver to search for A in the range 0 through 100.

Example: Calculating Profit for a Manufacturing Operation. The following Solver equation calculates the profit from a piano-manufacturing operation:

```
PIANOS:PROFIT=PRICE×QUAN-VARCOST×QUAN-FIXED
```

where	*PROFIT*	=	profit for the manufacturing operation.
	PRICE	=	the retail price of a piano.
	QUAN	=	the number of pianos sold.
	VARCOST	=	variable costs (per piano).
	FIXED	=	fixed costs.

The C-Sharp Piano Corporation sells pianos for $6,000. Variable costs are $4,100; fixed costs per year are $112,000. How many pianos must C-Sharp sell this year in order to earn a profit of $130,000? (In past years, C-Sharp has had to sell between 100 and 200 pianos to make an acceptable profit. You can use this information as initial guesses.)

Keys:	**Display:**	**Description:**
SOLVE ■ [↓]	▶	Displays the SOLVE menu and bottom of the equation list.

Type the PIANOS equation then:

CALC		Enters the equation and displays the menu of variables.
6000 PRICE	PRICE=6,000.00	Stores the price.

4100 VARCO	VARCOST=4,100.00	Stores the variable costs, fixed costs, and profit.
112000 FIXED	FIXED=112,000.00	
130000 PROFI	PROFIT=130,000.00	

The next two steps are optional. They enter guesses for *QUAN*. If the Solver must do a iterative search to solve for *QUAN*, it will begin the search using the estimates 100 and 200.

100 QUAN	QUAN=100.00	Enters the first guess for *QUAN*.
200 QUAN	QUAN=200.00	Enters the second guess for *QUAN*.
QUAN	QUAN:200.000000000 –	
	QUAN:100.000000000 +	
	⋮	
	QUAN=127.37	Solves for *QUAN* iteratively.

12

Writing Solver Equations

Introduction

Sometimes an equation printed in a book or written out longhand has to be adapted before it can be typed into the equation list. For example, examine the following equation for calculating the annual percent yield on a T-bill*, given the purchase price, as the equation might appear in a book:

$$\frac{\textit{Percent annual yield}}{100} = \frac{\$10{,}000 - \textit{Price}}{\textit{Price}} \times \frac{360 \text{ days}}{\textit{Days to maturity}}$$

The equation requires several changes before the Solver can understand it. In addition, an enhancement can be added to make the calculation easier; a Solver *function* can be included to calculate *Days to maturity*. Read "Rules for Writing Equations," below, to see how the changes are incorporated into the equation.

Rules for Writing Equations

The rules for writing equations use several terms:

- *Variables* are the named items for which you store or calculate values.
- *Constants* are numbers—for example, $10,000, 360 days.
- *Operators* perform arithmetic—for example, ×, and −.
- *Functions* do calculations using mathematical capabilities built into the Solver—for example, SQRT(x), USPV(*i*%:*n*), and DDAYS(*d1*:*d2*:*c*).

* The price in this equation is in terms of full units of $10,000.

Length of Equations. There is no limit to the length of the equation as long as there is sufficient memory to store it.

Variable Names. Solver variable names can be a maximum of 10 characters long and must be all one word (no spaces allowed). Names cannot begin with a number or decimal point, and cannot contain the characters +, −, ×, ÷, ^, (,), <, >, =, and :. For example, you could rewrite the T-bill equation as:

$$\frac{\%YIELD}{100} = \frac{\$10{,}000 - PRICE}{PRICE} \times \frac{360 \text{ days}}{DTM}$$

Shortened names, all uppercase letters

The first four or five characters of the variable names become menu labels in the menu of variables. Therefore, make sure no two variables have the same first four or five characters.

Constants. Constants must be keyed in as numbers without digit separators or other characters. For example:

Numbers written properly

$$\frac{\%YIELD}{100} = \frac{10000 - PRICE}{PRICE} \times \frac{360}{DTM}$$

Functions. An equation can contain any of the functions shown in table 12-1. For example, rather than computing *DTM* yourself, you can use the Solver function DDAYS with arguments *SDATE* (settlement date) *MDATE* (maturity date), and 3 (designating the 360-day calendar):

$$\frac{\%YIELD}{100} = \frac{10000 - PRICE}{PRICE} \times \frac{360}{\mathrm{DDAYS}(SDATE{:}MDATE{:}3)}$$

Operators, Parentheses, and the Order of Calculations. When necessary, use parentheses to control the order of calculations. Without parentheses, the Solver does calculations using these rules:*

- **Functions first.** For example, when solving for D in the equation `A×SQRT(B+C)=D`, the Solver calculates $\sqrt{(B+C)}$ and then multiplies the answer by A.
- **Exponentiation before multiplication and division.** For example, an equation typed in as `A×B^3=C` is interpreted as $A \times B^3 = C$. B is raised to the 3rd power and *then* multiplied by A. To raise $A \times B$ to the 3rd power, write the equation: `(A×B)^3=C`.
- **Multiplication and division before addition and subtraction.** For example, an equation typed in as `A+B÷C=12` is interpreted as:

$$A + \frac{B}{C} = 12$$

To divide the sum $A + B$ by C, type the equation: `(A+B)÷C=12`.

The T-bill equation can be written:

```
YIELD÷100=(10000-PRICE)÷PRICE×360÷
DDAYS(SDATE:MDATE:3)
```

A good rule is: when in doubt, use parentheses. So, if you were unsure of how the T-bill equation written above would be interpreted, you could type it as:

```
YIELD÷100=((10000-PRICE)÷PRICE)×(360÷
DDAYS(SDATE:MDATE:3))
```

The extra parentheses don't change the meaning of the equation, but they may make it easier to understand.

You cannot use parentheses for "implied" multiplication. For example, an equation printed in a book as $P_{sn} = P_s\,(1-F)$ can be typed into the Solver as `PSN=PS×(1-F)`. The $\times$ sign must be inserted between `PS` and the parenthesis.

* This differs from arithmetic in the calculator line, where calculations are done from left to right, regardless of the operators involved.

Spaces. You can use spaces to make the equation more readable as long as there are no spaces inside variable names and function names. The following version of the T-bill equation is easier to read:

```
YIELD = ( (10000-PRICE) ÷ PRICE) ×
(360÷ DDAYS(SDATE:MDATE:3) )
```

Conditional Expressions and Logical Operators. The Solver IF function, in combination with the logical operators in table 12-2, allow equations to do certain decision-making operations (see page 233). You cannot use logical operators as variable names. For example, you cannot name a variable AND, but *CANDY* and *LAND* are acceptable variable names.

Solver Functions

Table 12-1 lists the Solver functions. Lowercase characters in parentheses stand for numbers, variables names, or numeric expressions that the functions use to do their calculations.

Typing Aids. If a Solver function can also be done in the calculator line using a keyboard key or a menu key, that key is a typing aid for the function during equation entry.* For example, during equation entry:

▒ [√x]	displays SQRT(.
▒ [1/x]	displays INV(.
▒ [MATH] RND	displays RND(.
▒ [MATH] TRIG SIN	displays SIN(.

* An exception is the [%] key, which displays the character %.

Table 12-1. Solver Functions

Function	Description
ABS(*x*)	Absolute value.
ACOS(*x*)	Arc cosine.*
ACOSH(*x*)	Hyperbolic arc cosine.
ALOG(*x*)	Common (base 10) antilogarithm; 10^x.
ANGLE(*x*:*y*)	∡ polar coordinate for (*x*,*y*) rectangular coordinates.*
ASIN(*x*)	Arc sine.*
ASINH(*x*)	Hyperbolic arc sine.
ATAN(*x*)	Arc tangent.*
ATANH(*x*)	Hyperbolic arc tangent.
CDATE	Current date.†
COMB(*x*:*y*)	Number of combinations of *x* items taken *y* at a time.
COS(*x*)	Cosine.*
COSH(*x*)	Hyperbolic cosine.
CTIME	Current time in HH.MMSS, 24-hour format.
DATE(*date*:*n*)	The date *n* days after (when *n* is positive) or before (when *n* is negative) the specified *date*.†
DDAYS(*d1*:*d2*:*cal*)	The number of days between dates *d1* and *d2*.† *cal* designates the calendar: ■ *cal*=1 for the actual calendar, which recognizes leap years. ■ *cal*=2 for the 365-day calendar, which ignores leap years. ■ *cal*=3 for the 360-day calendar, which uses 12, 30-day months.
DEG(*x*)	Converts *x* in radians to decimal degrees.
EXP(*x*)	Natural antilogarithm; e^x.
EXPM1(*x*)	$e^x - 1$.
FACT(*x*)	Factorial; *x* is an integer ≥ 0 .

* Uses the current angle mode—degrees or radians.

† Uses the current date format (MM.DDYYYY or DD.MMYYYY). The date format is changed in the TIME SET menu.

Table 12-1. Solver Functions (continued)

Function	Description
FLOW(*name*:*x*)	Returns the value of FLOW(*x*) in the CFLO list with the specified *name* (see page 242).
FP(*x*)	Fractional part.
FV(*n*:*i%yr*:*pv*:*pmt*:*p/yr*:*m*)	TVM function for *FV* (see page 238).
HMS(*x*)	Converts *x* in decimal hours (degrees) to H.MMSS (D.MMSS) format.
HRS(*x*)	Converts *x* in H.MMSS (D.MMSS) format to decimal format.
IDIV(*x*:*y*)	Integer part of the quotient $x \div y$.
IF(*con*:*alg1*:*alg2*)	If conditional expression *con* is true, use algebraic expression *alg1*; otherwise, use *alg2* (see page 233).
INT(*x*)	The greatest integer less than or equal to *x*.
INV(*x*)	Reciprocal, $1/x$.
IP(*x*)	Integer part.
ITEM(*name*:*x*)	Returns value of entry(*x*) in the SUM list with the specified *name* (see page 241).
I%YR(*n*:*pv*:*pmt*:*fv*:*p/yr*:*m*)	TVM function for *I%YR* (see page 238).
LN(*x*)	Natural (base e) log.
LNP1(*x*)	$\ln(1 + x)$.
LOG(*x*)	Common (base 10) log of *x*.
MAX(*x*:*y*)	Larger of *x* and *y*.
MIN(*x*:*y*)	Smaller of *x* and *y*.
MOD(*x*:*y*)	The remainder of the division $x \div y$; MOD(*x*,*y*) = $x - y \times \text{INT}(x \div y)$.
N(*i%yr*:*pv*:*pmt*:*fv*:*p/yr*:*m*)	TVM function for *N* (see page 238).
PERM(*x*:*y*)	Permutations of *x* items taken *y* at a time.
PI	π; 3.14159265359 (12 digits).

Table 12-1. Solver Functions (continued)

Function	Description
PMT(*n*:*i%yr*:*pv*:*fv*:*p/yr*:*m*)	TVM function for *PMT* (see page 238).
PV(*n*:*i%yr*:*pmt*:*fv*:*p/yr*:*m*)	TVM function for *PV* (see page 238).
RAD(*x*)	Converts *x* in decimal degrees to radians.
RADIUS(*x*:*y*)	R polar coordinate for *(x,y)* rectangular coordinates.
RAN#	Pseudo-random number ($0 \leqslant r < 1$).
RND(*x*:*y*)	*x* rounded to *y* decimal places (when $0 \leqslant y \leqslant 11$) or to $\lvert y \rvert$ significant digits (when $-12 \leqslant y \leqslant -1$).
S(*var*)	*var* is a variable; used with the IF function to create a menu of variables from more than one equation. (See to page 236 for additional information.)
SGN(*x*)	Sign of *x* (+1 if $x>0$, 0 if $x=0$, -1 if $x<0$).
Σ(*cv*:*c1*:*c2*:*s*:*alg*)	Sums values of the algebraic expression (*alg*) for values of the counter variable (*cv*). *cv* starts with value *c1* and is incremented in steps of *s*, to a final value of *c2* (see page 241).
SIN(*x*)	Sine.*
SINH(*x*)	Hyperbolic sine.
SIZEC(*name*)	The group number of the last flow in the CFLO list with the specified *name* (see page 242).
SIZES(*name*)	The number of the entries in the SUM list with the specified *name* (see page 241).
SPFV(*i%*:*n*)	Future value of a single $1.00 payment; equivalent to $(1+i\%\div 100)^n$. *n* is the number of compounding periods. *i%* is the interest rate per compounding period, expressed as a percentage.
SPPV(*i%*:*n*)	Present value of a single $1.00 payment; equivalent to 1 ÷ SPFV(*i%*:*n*). *n* is the number of compounding periods. *i%* is the interest rate per compounding period, expressed as a percentage.

* Uses the current angle mode—degrees or radians.

Table 12-1. Solver Functions (continued)

Function	Description
SQ(x)	x^2.
SQRT(x)	$\sqrt{x}$.
#T(*name*:x)	Returns #TIMES for FLOW(x) of the CFLO list with the specified *name* (see page 242).
TAN(x)	Tangent.*
TANH(x)	Hyperbolic tangent.
TRN(x:y)	x truncated to y decimal places (when $0 \leqslant y \leqslant 11$) or to $\lvert y \rvert$ significant digits (when $-12 \leqslant y \leqslant -1$).
USFV(i%:n)	Future value of a uniform series of \$1.00 payments; equivalent to (SPFV(i%:n)$-$1) $\div$ (i% $\div$ 100). n is the number of payments. i% is the periodic interest rate, expressed as a percentage.
USPV(i%:n)	Present value of a uniform series of \$1.00 payments; equivalent to USFV(i%:n) $\div$ SPFV(i%:n). n is the number of payments. i% is the periodic interest rate, expressed as a percentage.
XCOORD(R:$\measuredangle$)	x-coordinate of polar coordinates.*
YCOORD(R:$\measuredangle$)	y-coordinate of polar coordinates.*

* Uses the current angle mode—degrees or radians.

Example: Calculating Purchasing Power After Inflation. The following equation, written as it might appear in a book, calculates the future value (*FVAL*) of a sum (*PVAL*) after any number of years (*YEARS*), given a constant percentage rate of inflation (*INFL%*).

$$FVAL = \frac{PVAL}{\left(1 + \frac{INFL\%}{100}\right)^{YEARS}}$$

Compare the denominator of the equation with the equation for the SPFV function on page 295. (The SPFV function calculates the future value of a single $1 payment.) Notice that if you replace *i%* and *n* in the SPFV equation with *INFL%* and *YEARS*, the two are identical. Thus, the Solver equation can be written:

```
FVAL=PVAL÷SPFV(INFL%:YEARS)
```

Part 1: Calculate the purchasing power of $10,000 after 10 years of 7% inflation per year.

Starting from the menu of variables for the equation:

Keys:	Display:	Description:
10000 PVAL	PVAL=10000.00	Stores the original amount.
7 INFL%	INFL%=7.00	Stores the inflation rate.
10 YEARS	YEARS=10.00	Stores the number of years.
FVAL	FVAL=5,083.49	Calculates the purchasing power in 10 years.

Part 2: What would the inflation rate have to be for the purchasing power to be reduced by only $2000 over the 10-year period?

8000 FVAL	FVAL=8,000.00	Stores desired purchasing power.
INFL%	INFL%=2.26*	Calculates the inflation rate.

* The Solver searches for an iterative solution (see page 219) and displays intermediate estimates.

Conditional Expressions (IF Function)

Equations can include conditional expressions using the IF function. For example, the Solver accepts the equation:

```
BONUS=IF(SALES>3000:.02×SALES:.01×SALES)
```

The two colons inside the parentheses stand for "THEN" and "OR ELSE." According to this equation, if *SALES* is greater than 3000, then the *BONUS* equals .02 × *SALES*; otherwise, *BONUS* equals .01 × *SALES*.

In general, the form of the IF function is:

IF(*conditional expression* : *algebraic expression* : *algebraic expression*)

The logical and relational operators that can be used in conditional expressions are described in table 12-2.

Table 12-2. Operators Used in Conditional Expressions.

Logical Operators	Relational Operators	
NOT	>	Greater than.
AND	<	Less than.
OR	=	Equal to.
XOR	>=	Greater than or equal to.
	<=	Less than or equal to.
	<>	Not equal to.

Order of Logical Operations. Logical operations are done after arithmetic operations (addition, subtraction, etc.). For example, the expression `IF(A+1 OR B=5:` is true if $A+1$ equals 5, B equals 5, or both $A+1$ and B equal 5. When there are two or more logical operators, they are done in the order `NOT` first, then `AND`, and finally `OR` or `XOR`. Thus, the expression `IF(A=360 AND B=12 OR A=365:` is true if A equals 360 and B equals 12, or if A equals 365.

Example: An Equation With a Conditional Expression. Use the *BONUS* Solver equation to calculate the bonus for a salesperson who generated $5000.00 in sales last month.

Starting from the menu of variables for the equation:

Keys:	**Display:**	**Description:**
5000 SALES	SALES=5,000.00	Stores the sales.
BONUS	BONUS=100.00	Calculates the bonus (.02 × *SALES*).

Here are several additional examples of equations using conditional expressions:*

Equation: `B=IF(7<A AND A<=15:2×A÷6:3×A+10)+C`
Meaning: If A is greater than 7 and less than or equal to 15, then $B=(2\times A\div 6)+C$. Otherwise, $B=(3\times A+10)+C$.

Equation: `VALUE=FIRST+IF(NOT FIRST=0:1÷FIRST:0)`
Meaning: If *FIRST* is unequal to 0, then $VALUE=FIRST+(1\div FIRST)$. If $FIRST=0$, then $VALUE=FIRST$.

Equation: `T=W×IF(A=0 XOR B=0:A+B:A×B)`
Meaning: $T=W\times(A+B)$ if A or B, but not both, equals 0. Otherwise, $T=W\times A\times B$. In other words,

When $A=0$ and $B\neq 0$, $T=W\times B$.
When $A\neq 0$ and $B=0$, $T=W\times A$
When $A=0$ and $B=0$, $T=0$
When $A\neq 0$ and $B\neq 0$, $T=W\times A\times B$.

Example: Using One IF Function Inside Another. An IF function can be used as the argument of another IF function. For example, suppose a corporation uses a rating system to determine salary. Employees are rated on a scale 1 through 3, and are given the following annual percent raise based on their rating:

* Conditional expressions containing algebraic expressions may cause the error `INVALID EQUATION`. If this happens, insert "+" before the left parenthesis. For example, change `IF((A+2)÷5<12:...` to `IF(+(A+2)÷5<12:...`

Rating	Percent Salary Increase
1	3%
2	6%
3	10%

The following equation calculates a new salary based on the previous salary and rating:

$$\mathtt{NSAL=OSAL\times(1+IF(R=1:}\underbrace{\mathtt{.03}}_{\text{Used if }R=1}\mathtt{:IF(R=2:}\underbrace{\mathtt{.06}}_{\text{Used if }R=2}\mathtt{:}\underbrace{\mathtt{.1}}_{\text{Used if }R\neq 1\text{ or }2}\mathtt{)))}$$

where *NSAL* = the new salary.

OSAL = the previous salary.

R = the rating; 1, 2, or 3.

Calculate the new annual salary for an employee with rating 2 who currently earns $27,500 annually.

Starting from the menu of variables for the equation:

Keys:	**Display:**	**Description:**
27500 OSAL	OSAL=27,500.00	Stores the old salary.
2 R	R=2.00	Stores the rating.
NSAL	NSAL=29,150.00	Calculates the new salary.

Creating Menus for Multiple Equations (S Function)

The S (solving for) function is used with the IF function to group equations and to specify the conditions under which one or the other is used. For example, consider these two equations for calculating gross pay:

Wage pay based on an hourly wage:

```
WPAY=WAGE×HRS
```

where:

WPAY = gross wage pay.
WAGE = hourly wage.
HRS = hours worked.

Salary pay based on a fixed salary plus a 5% sales commission:

```
SLPAY=SALRY+.05×SALES
```

where:

SLPAY = gross salary pay.
SALRY = the fixed salary.
SALES = sales.

To use the S function, the equations must first be rearranged to place 0 on one side of each equation:

```
WPAY-WAGE×HRS=0

SLPAY-SALRY-.05×SALES=0
```

To create one menu that can do either calculation, enter the equation:

Optional; =0 is implied if omitted

$$\text{IF(}\underbrace{\text{S(WPAY)}}_{\text{Solving for } WPAY\text{?}}\text{:}\underbrace{\text{WPAY-WAGE×HRS}}_{\text{If true: use this expression}}\text{:}\underbrace{\text{SLPAY-SALRY-.05×SALES}}_{\text{If false: use this expression}}\text{)=0}$$

The S function appears within the IF function in the conditional expression. In this case, the conditional expression is true if you solve for *WPAY*, and false if you solve for anything else. The algebraic expressions in the IF function are the two equations, rewritten to gather all the terms on one side of the equation, so that each expression is equal to 0.*

* The IF function can be set equal to an expression common to both equations. For example, the equations `X+Y+(10÷A)=Z` and `Q+R+(10÷A)=T` can be combined to `IF(S(X) OR S(Y) OR S(Z):X+Y-Z:Q+R-T)=-10÷A`. Note that the Solver uses the second equation when solving for *Q*, *R*, *T*, or *A*.

When you press CALC, the HP-19B displays:

```
 IF(S(WPAY):WPAY-WAGE×H
0.00
WPAY WAGE HRS SLPAY SALRY SALES
```

Figure 12-1. A Menu of Variables for Two Equations

Example: Using the S Function. Part 1: Calculate the weekly pay for an employee working 35 hours for $6.75 per hour.

Starting from the menu of variables for the equation:

Keys:	Display:	Description:
6.75 WAGE	WAGE=6.75	Stores wages and hours.
35 HRS	HRS=35.00	
WPAY	WPAY=236.25	Calculates wage pay.

Part 2: Calculate the monthly pay for an employee with a base salary of $1,800 who generated $5,000 in sales.

1800 SALRY		
5000 SALES	SALRY=1,800.000	
	SALES=5,000.00	
		Stores salary and sales.
SLPAY	SLPAY=2,050.00	Calculates salary pay.

The TVM Functions

The five Solver TVM functions allow you to write equations that do calculations analogous to the calculations done in the TVM menu:

N (	*i%yr* :	*pv* :	*pmt* :	*fv* :	*p/yr* :	*m*)
I%YR (	*n* :	*pv* :	*pmt* :	*fv* :	*p/yr* :	*m*)
PV (	*n* :	*i%yr* :	*pmt* :	*fv* :	*p/yr* :	*m*)
PMT (	*n* :	*i%yr* :	*pv* :	*fv* :	*p/yr* :	*m*)
FV (	*n* :	*i%yr* :	*pv* :	*pmt* :	*p/yr* :	*m*)

Each function calculates one TVM value, given the values for all the others. The parameters of the functions (the contents of the parentheses) are defined identically to the built-in TVM variables described in table 4-1 on page 77, except that *m* stands for the Begin/End mode. Use $m=1$ for Begin mode, $m=0$ for End mode. For example, the first function calculates *N* (the total number of payments or compounding periods), given the annual percentage interest rate, present value, payment amount, future value, number of payments per year, and the Begin/End mode.

You can give the parameters any legal variable name; for example you can use LOAN in place of *pv*. Parameters can also be algebraic expressions. For example, the following equation calculates the monthly payment for a car loan:

$$\text{CARPMT=PMT(}\underbrace{\text{MONTHS}}_{n}\text{:I\%YR:}\underbrace{\text{PRICE-DOWN}}_{pv}\text{:0:12:}\underbrace{\text{0}}_{\text{End mode}}\text{)}$$

where *MONTHS* is the duration of the loan (in months), *PRICE* is the purchase price, and *DOWN* is the down payment ($pv = PRICE - DOWN$). Notice that PMT is *not* a variable in the equation—it is the name of the function.

The Solver TVM variables are not shared with the variables in the TVM menu. For example, the variable *I%YR* in the *CARPMT* equation is separate from the TVM menu variable *I%YR*.

Example: Homeowners' Monthly Payment Estimator. Monthly house payments often include payments for taxes and insurance. The following Solver equation calculates the payment, assuming that the assessed value of the house equals its purchase price.

```
PAYMT=PMT(N:I%YR:PRICE-DOWN:0:12:0)-
TAX×PRICE÷12000-INSUR÷12*
```

where	*PAYMT*	=	monthly house payment.
	N	=	total number of payments to repay the mortgage.
	I%YR	=	annual interest rate.
	PRICE	=	purchase price of the house.
	DOWN	=	down payment.
	TAX	=	tax rate per $1,000 assessed value.
	INSUR	=	cost of insurance per year.

For example, suppose you put 10% down on a $65,000 house, and take out a 10¼%, 35-year loan. If the tax rate is $25 per thousand, and insurance is $600 per year, what are your monthly payments?

Starting from the menu of variables for the equation:

Keys:	**Display:**	**Description:**
35 [×] 12		Stores number of periods, interest rate, and house price.
N	N=420.00	
10.25 I%YR	I%YR=10.25	
65000 PRICE	PRICE=65,000.00	
[×] 10 [%]		Calculates and stores the down payment.
DOWN	DOWN=6,500.00	
MORE		Stores the tax rate.
25 TAX	TAX=25.00	

* The minus signs before TAX and INSUR are necessary in order for the taxes and insurance to increase the payment amount (*PAYMT*), since the value calculated by the PMT function is a negative number (see "Cash Flow Diagrams and Signs of Numbers" on page 78).

600 INSUR	INSUR=600.00	Stores insurance.
MORE PAYM	PAYMT=-699.55	Calculates monthly payment.

Example: Using the Solver to Calculate APR of a Loan With Fees. The following equation uses a TVM Solver function to calculate the APR (*annual percentage rate*) of a loan with fees. (Using the TVM menu to calculate the APR was covered in chapter 4; see page 105.)

```
APR=I%YR(N:LOAN-FEES:PMT(N:I%YR:LOAN:0:12:0):0:12:0)
```

where *N* = the total number of payments for the loan.

LOAN = the loan amount.

FEES = the sum of all the fees for the loan.

I%YR = the annual interest rate.

Notice that I%YR appears twice in the equation—as the TVM function, and as a variable. The two occurrences are independent of one another.

Use the APR Solver equation to calculate APR for a $60,000, 30-year mortgage. The annual interest rate is 11½%, and the borrower is charged two points (2% of the mortgage amount) in fees.

Starting from the menu of variables for the equation:

Keys:	**Display:**	**Description:**
30 [×] 12 N 60000 LOAN	 N=360.00 LOAN=60,000.00	Stores the number of payments and mortgage amount.
[×] 2 [%] FEES	 FEES=1,200.00	Calculates and stores the fees.
11.5 I%YR	I%YR=11.50	Stores the annual interest rate.
APR	APR=11.76	Calculates APR.

The Summing Function (Σ)

The Σ function provides the ability to do a variety of summing operations. The function has the form:

Σ(*counter variable* : *starting value* : *ending value* : *step size* : *algebraic expression*)

The *counter variable* takes on a series of values, beginning with the *starting value,* and incrementing according to the *step size,* until it passes the *ending value*. For each value of the counter, the *algebraic expression* is evaluated, and the value is added to the previous value. The function returns the final summation. The counter variable does not appear in the menu of variables.

The following equation contains a counter *I* and two other variables, *X* and *THESUM*:

```
THESUM=Σ(I:1:6:1:I×X)
```

The counter *I* runs from 1 through 6 in steps of 1—that is, 1, 2, 3, 4, 5, 6. For each value *I*, $I \times X$ is calculated and added to the sum. If you store 3 in *X* and then solve for *THESUM*, the Solver calculates $THESUM = 63$ $(3+6+9+12+15+18)$.

The next equation uses a variable as the ending value, 0 as the beginning value, and a step size of 2:

```
THISSUM=Σ(I:0:LAST:2:2×I×X)
```

If $X = 3$ and $LAST = 8$, *I* takes on values of 0, 2, 4, 6, and 8. Solving for *THISSUM* calculates $THISSUM = 120$ $(0 + 12 + 24 + 36 + 48)$.

Solver Functions That Use SUM Lists

Two functions allow the Solver to use information stored in SUM lists:

- SIZES(*listname*) returns the number of entries in the specified SUM list.
- ITEM(*listname* : *x*) returns the value of entry(*x*) in the specified SUM list.

For example, the following equation calculates $\Sigma x_i^2 y_i^2$ for two listsnamed X and Y that have the same number of items:

Counter

End summing at last entry in list X.

```
SX2Y2=Σ(I:1:SIZES(X):1:ITEM(X:I)^2×ITEM(Y:I)^2)
```

Begin summing with $I=1$

Increment I by 1

$X(I)^2 \times Y(I)^2$

Solver Functions That Use CFLO Lists

Three functions allow the Solver to use information stored in CFLO lists:

- `SIZEC(`*listname*`)` returns the *group number* of the last flow in the specified CFLO list. For example, if the last entries are FLOW(8) and #TIMES(8), SIZEC returns 8.
- `FLOW(`*listname* `:` *x*`)` returns the value of FLOW(*x*) in the specified CFLO list.
- `#T(`*listname* `:` *x*`)` returns the value of #TIMES(*x*) in the specified CFLO list.

13

Solver Examples

Introduction

Table 13-1 lists the example equations in this chapter and the functions they use.

Table 13-1. Solver Examples

Example	Solver Functions Used	Page
Simple Annual Interest	DDAYS, IF	**244**
Loans With an Odd (Partial) First Period	PV, FP, IF	**246**
Canadian Mortgages	FV	**248**
Advance Payments (Leasing)	USPV, SPPV	**249**
Price of an Insurance Policy		**250**
Discounted Notes	DDAYS	**253**
Moving Average	Σ, ITEM, MAX, MIN	**254**
Chi-Squared (χ^2) Statistics	Σ, ITEM, SIZES	**256**
Modified Internal Rate of Return	Σ, SIZEC, FLOW, #T, MAX, MIN, USPV, USFV, SPPV, SPFV	**258**
Economic Ordering Quantity	SQRT	**260**
Simulating a Toss of Dice	IP, RAN#	**262**
Distance Between Two Locations	ACOS, SIN, HRS, COS	**262**
Number of Days Until a Special Day	DDAYS, CDATE, FP, IF	**263**
Finding Several Solutions to an Equation		**264**

Simple Annual Interest

The following equation calculates the amount due for a loan with simple annual interest, given the duration of the loan. Both the principal and interest are paid in a lump sum at the end of the loan period. The equation assumes a 365-day calendar basis.

```
LOAN,DAYS:DEBT = LOAN + LOAN × I% ÷
100 × DAYS ÷ 365
```

where *DEBT* = the total owed at the end of the loan period.

LOAN = the original amount (principal) lent.

I% = the annual interest rate as a percent.

DAYS = the number of days in the loan.

The next equation can be used if you know the dates for the course of the loan, rather than the number of days:

```
LOAN,DATES:DEBT = LOAN + LOAN × I% ÷ 100 ×
DDAYS(DATE1:DATE2:IF(BASIS=365:1:3)) ÷ BASIS
```

where *DATE1* = the date the loan commences.

DATE2 = the date the loan ends.

BASIS = 365 for a 365-day basis.

= 360 for a 360-day basis.

Example: Simple Interest for a Specified Number of Days. You lend a friend $450 for 60 days, charging 7% simple annual interest (calculated on a 365-day basis). How much interest will she owe you in 60 days, and what is the total amount owed?

Starting from the menu of variables for the equation named LOAN,DAYS:

Keys:	Display:	Description:
450 LOAN	LOAN=450.00	Stores loan amount.
7 I%	I%=7.00	Stores interest rate.
60 DAYS	DAYS=60.00	Stores term of loan.
DEBT	DEBT=455.18	Calculates amount due in 60 days.

Example: Simple Interest From the Dates of the Loan. On March 30, 1988, you borrow $1,200 from a relative. You promise to repay the loan, with 8% simple interest (to be calculated on a 365-day basis), on June 16, 1989. How much will you owe?

Starting from the menu of variables for the equation named LOAN,DATES:

Keys:	Display:	Description:
1200 LOAN	LOAN=1,200.00	Stores loan amount.
8 I%	I%=8.00	Stores interest rate.
3.301988 DATE1	DATE1=3.30	Stores date of loan.
6.161989 DATE2	DATE2=6.16	Stores repayment date.
365 BASIS	BASIS=365.00	Stores calendar basis.
DEBT	DEBT=1,316.52	Calculates amount to be repaid.

Loans With an Odd (Partial) First Period

The TVM menu requires all payment periods to be the same length. However, situations exist in which the first payment period does not equal the remaining periods. That period (from the date that interest begins accruing to the date of the first payment) is sometimes called an *odd* or *partial first period.*

The following Solver equation does calculations involving an odd first period, using simple interest for the odd period. The equation is valid for 0 to 59 days from inception to first payment, and assumes a 30-day month.*

```
ODD:(I%YR÷100÷P/YR×FP(DAYS÷30)+1)×PV
-PV(N:I%YR:PMT:FV:P/YR:IF(DAYS<30:1:0))=0
```

where	*I%YR*	=	the nominal annual interest rate, as a percentage.
	P/YR	=	the number of payment periods per year.
	DAYS	=	the actual number of days until the first payment is made.
	PV	=	the loan amount.
	N	=	the total number of payment periods.
	PMT	=	the periodic payment.
	FV	=	the balloon payment.

Example: Loan With an Odd First Period. A 36-month loan for $4,500 has an annual interest rate of 15%. If the first payment is made in 46 days, what is the monthly payment amount?

* You do not need to specify Begin or End mode. If the odd period is less than 30 days, Begin mode is assumed. If the odd period is between 30 and 59 days, inclusive, End mode is assumed.

Starting from the menu of variables for the equation named ODD:

Keys:	Display:	Description:
15 I%YR	I%YR=15.00	Stores the annual interest rate.
12 P/YR	P/YR=12.00	Stores the number of payments per year.
46 DAYS	DAYS=46.00	Stores days until first payment.
4500 PV	PV=4,500.00	Stores loan amount.
36 N	N=36.00	36 payment periods.
MORE 0 FV	FV=0.00	No balloon payment.
PMT	PMT=-157.03	Calculates monthly payment amount.

Example: Loan With an Odd First Period Plus Balloon. A $10,000 loan has 24 monthly payments of $400, plus a balloon payment of $3,000 at the end of the 24th month. If the payments begin in 8 days, what annual interest rate is being charged?

Starting from the menu of variables for the equation named ODD:

Keys:	Display:	Description:
12 P/YR 8 DAYS 10000 PV 24 N	P/YR=12.00 DAYS=8.00 PV=10,000.00 N=24.00	Stores variables on first page of the menu.
MORE 400 +/- PMT 3000 +/- FV	 PMT=-400.00 FV=-3,000.00	Stores remaining known variables.
MORE I%YR	I%YR=19.67	Iterative solution for annual interest rate.

Canadian Mortgages

In Canadian mortgages, interest is compounded semi-annually while payments are made monthly. The following Solver equation can be used to calculate Canadian Mortgages:*

```
CAN: FV(N:((1+CI%YR÷200)^(1÷6)-1)
×1200:PV:PMT:12:0)=FV
```

where		
	N =	total number of payment periods for the life of the loan.
	$CI\%YR$ =	annual (Canadian) interest rate as a percent.
	PV =	the loan amount, or present value.
	PMT =	periodic payment amount.
	FV =	remaining balance, or future value.

Example: Calculating the Payment for a Canadian Mortgage. What is the monthly payment required to fully amortize a 30-year, $50,000 Canadian mortgage if the interest rate is 9%?

Starting from the menu of variables for the equation named CAN:

Keys:	Display:	Description:
30 [×] 12		Stores known values.
N	N=360.00	
9 CI%YR	CI%YR=9.00	
50000 PV	PV=50,000.00	
0 FV	FV=0.00	
PMT	PMT=-396.42	Calculates the payment.

Example: Calculating the Interest Rate for a Canadian Mortgage. A Canadian mortgage has monthly payments of $612.77 with a maturity of 25 years. The principal amount is $75,500. What is the annual interest rate?

* Canadian mortgages can also be calculated using the TVM and ICONV menus. See page 101 for an example.

Keys:	Display:	Description:
612.77 [+/-]		Stores known values.
PMT	PMT=-612.77	
75500 PV	PV=75,500.00	
25 [×] 12		
N	N=300.00	
0 FV	FV=0.00	
CI%YR	CI%YR=8.75	Calculates annual interest rate.

Advance Payments (Leasing)

Occasionally payments are made in advance, such as in leasing. Leasing agreements sometimes call for the extra payments to be made when the transaction is closed. A residual value (*salvage value*) can also exist at the end of the normal term.

The following equation calculates the monthly payment and the annual yield when one or more payments are made in advance. It can be modified to accommodate periods other than monthly by changing the number 12 to the appropriate number of payment periods per year.

```
ADV: PMT=(-PV-FV×(SPPV(I%YR÷12:N)))÷
(USPV(I%YR÷12:N-#ADV)+#ADV)
```

where *PMT* = the monthly payment amount.
PV = the value of the equipment.
FV = the residual value.
I%YR = the annual interest rate as a percent.
N = the total number of payments.
#ADV = the number of advance payments.

Example: Leasing With Advance Payments. Equipment worth $750 is leased to you for 12 months. The equipment is assumed to have no salvage value at the end of the lease. You agree to make three payments at the time of closing. What is the monthly payment if the annual interest rate is 10%?

Starting from the menu of variables for the equation named ADV:

Keys:	**Display:**	**Description:**
750 PV	PV=750.00	Stores known values.
12 N	N=12.00	
0 FV	FV=0.00	
3 #ADV	#ADV=3.00	
10 I%YR	I%YR=10.00	
PMT	PMT=-64.45	Calculates monthly payment.

Price of an Insurance Policy

The price of an insurance policy, other than term life insurance, is rarely apparent at first glance. The price should include not only the premium payments, but also the interest that could have been earned on the cash value or *savings portion* of the policy.

The following equation calculates the price per $1,000 of protection for one policy year and the interest rate earned on the savings portion of the policy.*

* Reference: Joseph M. Belth, *Life Insurance—A Consumer's Handbook,* Indiana University Press, 1973, p. 234.

```
POLICY: INS=((PREM+LVAL)×(1+I%÷100)-VAL-DIV)
÷(.001×(FACE-VAL))
```

where *INS* = the price per $1,000 of protection in one policy year.

PREM = the annual premium amount.

LVAL = the value of the policy at the end of last year.

I% = the rate of return, as a percent .

VAL = the value of the policy at the end of the current year.

DIV = the dollar value of the dividend for one year.

FACE = the face value of the policy for one year.

To calculate the price, assume some value for interest—for example, the interest rate you could earn on a one-year savings certificate after tax. Similarly, to calculate interest, assume a price per $1,000 of protection per year for alternative insurance; for example, a low-cost term policy of the one-year renewable type.

Even complex policies like minimum-deposit plans can be analyzed with this procedure. Use policy surrender values for cash values and the actual (after-tax) amounts for payments (premiums) and dividends.

Example: Price of an Insurance Policy. Part 1: You are evaluating your $50,000 insurance policy. The premium of $1,010 is due at the beginning of the year, and a dividend of $165 is received at the end of the policy year. The cash value of the policy is $3,302 at the beginning of the year, and it will grow to $4,104 by the end of the year. You can earn 6% on a savings account. What is the price per $1,000 protection per year?

Starting from the menu of variables for the equation named POLICY:

Keys:	**Display:**	**Description:**
1010 PREM	PREM=1,010.00	Stores annual premium.
3302 LVAL	LVAL=3,302.00	Stores value of policy at end of last year.
6 I%	I%=6.00	Stores interest rate you could get elsewhere.
4104 VAL	VAL=4,104.00	Stores value of policy at end of this year.
MORE 165 DIV	DIV=165.00	Stores annual dividend.
50000 FACE	FACE=50,000.00	Stores face value of policy.
MORE INS	INS=6.57	Your protection cost $6.57 per $1,000 face (protection) value.

Part 2: Insurance protection could be purchased for $3 per $1,000 face value. Calculate the rate of return on your savings.

3 INS	INS=3.00	Stores price of alternate insurance.
I%	I%=2.20	Calculates rate of return on your savings.

Discounted Notes

A note is a written agreement to pay the buyer of the note a sum of money plus interest. Notes do not have periodic coupons, since all interest is paid at maturity. A discounted note is a note that is purchased below its face value. The following equations find the price or yield of a discounted note. The calendar basis is actual/360.

To find the price given the discount rate:

```
NOTE,PRICE:PRICE=RV-(DISC×RV×DDAYS(SETT:MAT:1)
÷36000)
```

To find the yield given the price (or to find the price given the yield):

```
NOTE,YIELD:YIELD=(RV-PRICE)÷PRICE×36000
÷DDAYS(SETT:MAT:1)
```

where *PRICE* = the purchase price per $100 face value.

YIELD = the yield as an annual percentage.

RV = the redemption value per $100.

DISC = the discount rate as a percent.

SETT = the settlement date (in current date format).

MAT = the maturity date (in current date format).

Example: Price and Yield of a Discounted Note. What are the price and yield of the following U.S. Treasury Bill: settlement date October 14, 1988; maturity date March 17, 1989; discount rate 8.7%? (Assume month/day/year format.)

Starting from the menu of variables for the equation named NOTE,PRICE:

Keys:	Display:	Description:
10.141988		Stores known values.
SETT	SETT=10.14	
3.171989		
MAT	MAT=3.17	
8.7 DISC	DISC=8.70	
100 RV	RV=100.00	
PRICE	PRICE=96.28	Calculates price.
EXIT	▶NOTE,PRICE:PRICE=RV-(D	Displays the SOLVE menu.

Type (or display) the equation named NOTE,YIELD and press CALC to display the menu of variables. Then:

YIELD	YIELD=9.04	Calculates yield.

Moving Average

Moving averages are often used to predict trends in data over time. In moving average calculations, a specified number of values are averaged. Each time a new value is acquired, the oldest is discarded.

The following Solver equation calculates the moving average of data stored in a SUM list:

```
MOVAVG: MAVG=Σ(I:MAX(1:LAST-N+1):LAST:1:ITEM
(name:I))÷MIN(LAST:N)
```

where N = the number of values averaged in each calculation.

$LAST$ = the entry number of the most recent value to be averaged.

name = the name of the SUM list.

Example: Moving Average. Calculate a three-month moving average for the number of units manufactured during the first half of the year. Manufacturing volumes were:

January	February	March	April	May	June
4400	5360	2900	3670	4040	3200

Keys:	Display:	Description:
SUM *		Displays the SUM menu.
■ [CLEAR DATA] YES		Clears the list.
4400 [INPUT] 5360 [INPUT] 2900 [INPUT] 3670 [INPUT] 4040 [INPUT] 3200 [INPUT]	ITEM(7)= TOTAL=23,570.00	Enters data.
NAME VOL [INPUT]	ITEM(7)= TOTAL=23,570.00	Names the list VOL.
■ [MAIN] SOLVE ■ [↓]	▶	Displays SOLVE menu and bottom of equation list.

Type the equation, substituting VOL for *name*, and press CALC to display the menu of variables. Then:

3 N	N=3.00	Stores number of points.
3 LAST	LAST=3.00	Stores entry number of last entry to be averaged.
MAVG	MAVG=4,220.00	Calculates average for months 1, 2, and 3.

* If you want to preserve the current list, skip the next step (pressing ■ [CLEAR DATA]). Instead, name the list (refer to page 158), and then press GET *NEW .

4 LAST	LAST=4.00	"Moves" *LAST* down one entry.
MAVG	MAVG=3,976.67	Calculates average for months 2, 3, and 4.
5 LAST	LAST=5.00	"Moves" *LAST* down one entry.
MAVG	MAVG=3,536.67	Calculates average for months 3, 4, and 5.
6 LAST MAVG	MAVG=3,636.67	Calculates average for months 4, 5, and 6.

Chi-Squared (χ^2) Statistics

The Chi-squared statistic is a measure of the goodness of fit between data and an assumed distribution.* It is used to test whether a set of observed frequencies differs from a set of expected frequencies sufficiently to reject the hypothesis under which the expected frequencies were obtained. In other words, you are testing whether discrepancies between the observed frequencies (O_i) and the expected frequencies (E_i) are significant, or whether they may reasonably be attributed to chance. The equation is:

$$\chi^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$$

If there is close agreement between the observed and expected frequencies, χ^2 is small; if the agreement is poor, χ^2 is large.

The following Solver equations calculate χ^2 using data in one or two SUM lists:

If the expected values vary:

```
1:CHI2=Σ(I:1:SIZES(name1):1:(ITEM(name1:I)
-ITEM(name2:I))^2÷ITEM(name2:I))
```

* The statistic can be assumed to be χ^2 distributed with $n-1$ degrees of freedom if n or some of the E_i values are large.

If the expected value is a constant:

```
2:CHI2=Σ(I:1:SIZES(name1):1:(ITEM(name1:I)
-EXPT)^2÷EXPT)
```

where	*CHI2*	=	χ^2.
	name1	=	the name of the list containing the observed values.
	name2	=	the name of the list containing the expected values.
	EXPT	=	the expected value, if constant.

Example: χ^2**.** To determine whether a suspect die is biased, you toss it 120 times and observe the following results. (The expected frequency is the same for each number, 120 ÷ 6.)

Number	1	2	3	4	5	6
Observed Frequency	25	17	15	23	24	16

Keystrokes:	**Display:**	**Description:**
SUM *		Displays the SUM menu.
■ CLEAR DATA		Clears the list.
YES	ITEM(1)=	
25 INPUT 17 INPUT 15 INPUT 23 INPUT 24 INPUT 16 INPUT	ITEM(7)= TOTAL=120.00	Enters observed values.
NAME OB INPUT	ITEM(7)= TOTAL=120.00	Names the list OB.

* If you want to preserve the current list, skip the next step (pressing ■ CLEAR DATA). Instead, name the list (refer to page 158), and then press GET *NEW .

■ [MAIN]
SOLVE ■ [↓] ▸ Displays SOLVE menu and bottom of equation list.

Type equation 2, substituting OB for *name1*. Press CALC to display the menu of variables, then:

120 [÷] 6		Stores expected value.
EXPT	EXPT=20.00	
CHI2 *	CHI2=5.00	Calculates χ^2.

The number of degrees of freedom is $(n-1) = 5$. Consult statistical tables to find χ^2 to a significance level of 0.05 with 5 degrees of freedom. The table shows that $\chi^2_{0.05,5} = 11.07$. Since the computed value (5.00) is less than 11.07, you can conclude that, to a 0.05 significance level (95% probability), the die is fair.

Modified Internal Rate of Return

Chapter 5 contains an example that calculates *Modified Internal Rate of Return* (*MIRR*) using two CFLO lists and the TVM menu. The following Solver equation calculates *MIRR* using one CFLO list for all the cash flows:

```
MODIRR: (1+MIRR÷100) ^ Σ(L:1:SIZEC(name):1:#T
(name:L))=
-Σ(J:0:SIZEC(name):1:MAX(FLOW(name:J):0)
× USFV(RISK:#T(name:J))
× SPFV(RISK:Σ(L:J+1:SIZEC(name):1:#T(name:L))))
÷(MIN(FLOW(name:0):0)+Σ(J:1:SIZEC(name):1:
MIN(FLOW(name:J):0)×USPV(SAFE:#T(name:J))
×SPPV(SAFE:Σ(L:1:J-1:1:#T(name:L)))))
```

* If the HP-19B doesn't display CALCULATING..., press CHI2 again.

where	*MIRR* =	the periodic modified internal rate of return.
	name =	the name of the CFLO list.
	RISK =	the periodic risk reinvestment rate, expressed as a percentage (see page 129).
	SAFE =	the periodic safe rate, expressed as a percentage (see page 129).

Enter the equation into the Solver, substituting an appropriate list name for *name*. Once the equation has been entered, use the following procedure to calculate *MIRR*:

1. Enter all the cash flows into a CFLO list. Name the list the same name used in the Solver equation.
2. Display the menu of variables for the Solver equation.
3. Store values for *SAFE* and *RISK* by keying in values and pressing the menu keys.
4. Press MIRR to calculate *MIRR*. The value calculated is the periodic rate of return. To calculate the annual rate of return, multiply by the number of periods per year.

Calculating Modified IRR Using the Solver. Use the Solver equation to calculate the modified IRR for the cash flows shown in figure 5-11 on page 130.

Keys:	Display:	Description:
FIN CFLO *		Displays the CFLO menu.
■ [CLEAR DATA] YES	▶INIT=	Clears the list.
180000 [+/-] [INPUT]	▶FLOW(1)= #TIMES=	Stores initial cash flow.

* If you want to preserve the current list, skip the next step (pressing ■ [CLEAR DATA]). Instead, name the list (refer to page 116), and then press GET *NEW .

100000 [INPUT]		
5 [INPUT]		
100000 [+/-]		
[INPUT]		
5 [INPUT]		
0 [INPUT]		
9 [INPUT]		
200000 [INPUT]	FLOW(4)=200,000.00 ▶#TIMES=1	Enters grouped flows 1 through 4.
NAME INV [INPUT]	▶FLOW(5)= #TIMES=	Names the list INV.

Type the MODIRR equation, substituting INV for *name*. Press CALC to display the menu of variables, then:

13 [÷] 12 RISK	RISK=1.08	Stores the periodic risk rate.
8 [÷] 12 SAFE	SAFE=0.67	Stores the periodic safe rate.
MIRR	MIRR=1.02	Calculates periodic *MIRR*.
[×] 12 [=]	12.18	Calculates annual *MIRR*.

Economic Ordering Quantity

The *economic ordering quantity* is the optimum quantity to order each time an order is placed. It is based on the cost of placing and receiving an order, annual sales, carrying costs (including warehousing costs, interest on funds tied up in inventory, insurance, and obsolescence), and the purchase price of the goods.

The following Solver equation calculates economic order quantity:

```
EOQ=SQRT(2×FIXCO×SALES÷(CARY%÷100×PRICE))
```

where *EOQ* = the economic ordering quantity.

FIXCO = the fixed costs of placing and receiving an order.

SALES = the annual unit sales.

CARY% = the carrying costs as a percentage of inventory.

PRICE = the purchase price per unit of inventory.

Example: Economic Ordering Quantity. Your annual sales are 10,000 units. The purchase price per unit is $4.73. Carrying cost is 20% of inventory value and the cost of placing and receiving an order is $35. Calculate the economic ordering quantity.

Starting from the menu of variables for the equation:

Keys:	**Display:**	**Description:**
35 FIXCO	FIXCO=35.00	Stores fixes cost of placing order.
10000 SALES	SALES=10,000.00	Stores annual unit sales.
20 CARY%	CARY%=20.00	Stores carry cost.
4.73 PRICE	PRICE=4.73	Stores price per unit.
EOQ	EOQ=860.21	Calculates *EOQ*.

Simulating a Toss of Dice

The Solver random number function RAN# can simulate the toss of one or more six-sided dice. The equation:

```
TOSS=IP(RAN#×6+1)
```

generates integers in the range 1 through 6. Similarly,

```
TOSS=IP(RAN#×6+1)+IP(RAN#×6+1)
```

simulates the toss of two dice.

1. Press SOLVE ■ [↓] to display the bottom of the equation list.
2. Type the equation for the appropriate number of dice and press CALC .
3. Press TOSS as many times as desired to see the results of the tosses.

Distance Between Two Locations

The following Solver equation calculates the approximate statute miles between two places, given their longitudes and latitudes.* The longitudes and latitudes are entered in Degrees.MinutesSeconds format (D.MMSSss); South Latitude and East Longitude are negative numbers. The calculator must be in Degrees mode.

```
DISTANCE=69.0466×ACOS(SIN(HRS(LT1))
×SIN(HRS(LT2))+COS(HRS(LT1))×
COS(HRS(LT2))×COS(HRS(LG1)-HRS(LG2)))
```

where *LG1*, *LT1* = the longitude and latitude of the first place.

LG2, *LT2* = the longitude and latitude of the second place.

* You can use the UNITS LENG menu to convert statute miles to other units.

Example: Calculating the Distance Between Two Places. Find the statute miles between Philadelphia, Pennsylvania (40°35′N, 75°10′W) and Corvallis, Oregon (44°35′N, 123°16′W).

Starting from the menu of variables for the equation:

Keys:	**Display:**	**Description:**
If the (2π) annunciator is on, press ■ [MODES] D/R [EXIT] to set Degrees mode.		
40.35 LT1	LT1=40.35	Stores latitude and longitude for Philadephia.
75.10 LG1	LG1=75.10	
44.35 LT2	LT2=44.35	Stores latitude and longitude for Corvallis.
123.16 LG2	LG2=123.16	
DISTA	DISTANCE=2,425.31	Calculates statute miles.

Number of Days Until a Special Day

The following equation calculates the number of days between today's date and some other meaningful date within one year from today—for example, Christmas. The TIME calendar must be set to today's date.

$$\texttt{WHEN?: SANTA= DDAYS(CDATE:}\overbrace{\texttt{12.25}}^{\text{Christmas}}\texttt{+.01×}$$
$$\texttt{FP(CDATE×100+IF(CDATE<=}\underbrace{\texttt{12.25}}_{\text{Christmas}}\texttt{+.01:0:1E-4)):1)}$$

For other special days, replace 12.25 with the special day, expressed in MM.DD format.

Example: How Many Days Until Christmas? If today is April 20, 1988, how many days remain until Christmas?

Starting from the menu of variables for the equation named WHEN?:

Keys:	**Display:**	**Description:**
SANTA	SANTA=249.0000	Calculates number of days until 12/25/1988.

Finding Several Solutions to an Equation

The equation $x^3 - 5x^2 = 10x - z$ can have more than one solution for x. The Solver can find each solution if you enter appropriate guesses. Here is one way to determine appropriate guesses:

1. Algebraically rearrange the equation so that all the terms are on the left side. For example, $x^3 - 5x^2 = 10x - z$ can be rearranged to:

$$x^3 - 5x^2 - 10x + z = 0$$

2. Replace "0" with a new, "dummy" variable.

$$x^3 - 5x^2 - 10x + z = \underbrace{y}_{\text{Dummy variable}}$$

3. Enter the equation `X^3-5×X^2-10×X+Z=Y` and display its menu of variables.
4. Store the known values. For example, if you are calculating x for $z=20$, store 20 in z.
5. Store various values for the unknown (x) and calculate the dummy variable (y). Look for places where y changes sign. These are values of x that "bracket" a solution to the equation.
6. To solve the equation for a particular solution, store 0 in y. Then, enter the bracketing values as guesses for x and solve for x.

The following table shows (x,y) values for $x^3 - 5x^2 - 10x + z = y$ for $z = 20$. Figure 13-1 shows a graph of y versus x.

X	Y	X	Y
−10	−1,380.00	1	6.00
−9	−1,024.00	2	−12.00
−8	−732.00	3	−28.00
−7	−498.00	4	−36.00
−6	−316.00	5	−30.00
−5	−180.00	6	−4.00
−4	−84.00	7	48.00
−3	−22.00	8	132.00
−2	12.00	9	254.00
−1	24.00	10	420.00
0	20.00		

Sign change

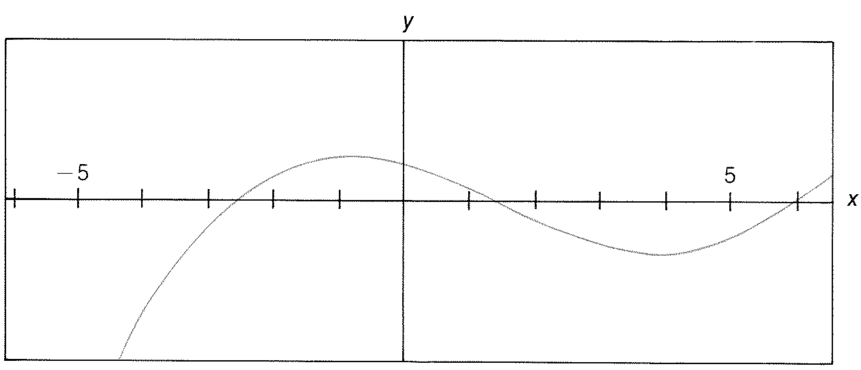


Figure 13-1. *y* Versus *x* for $y = x^3 - 5x^2 - 10x + 20$

To find the three solutions to the equation:

Keys:	**Display:**	**Description:**
0 Y	`Y=0.00`	Stores 0 in *Y*.
3 [+/-] X	`X=-3.00`	Stores guesses.
2 [+/-] X	`X=-2.00`	
X	`X=-2.44`	Calculates first root.
1 X	`X=1.00`	Stores guesses.
2 X	`X=2.00`	
X	`X=1.34`	Calculates second root.
6 X	`X=6.00`	Stores guesses.
7 X	`X=7.00`	
X	`X=6.10`	Calculates third root.

Appendixes and Index

A

Assistance, Batteries, Memory, and Service

Obtaining Help in Operating the Calculator

We at Hewlett-Packard are committed to providing the owners of HP calculators with ongoing support. You can obtain answers to your questions about using the calculator from our Calculator Support department.

We suggest that you read the next section, "Answers to Common Questions," before contacting us. Past experience has shown that many of our customers have similar questions about our products.

If you don't find an answer to your question, you can contact us using the address or phone number listed on the inside back cover.

Answers to Common Questions

Q: I'm not sure if the calculator is malfunctioning or if I'm doing something incorrectly. How can I determine if the calculator is operating properly?

A: Refer to page 279, which describes the diagnostic self-test.

Q: My arithmetic keys don't work like I expect. I press 12 [+] 3 [=] and get 3.

A: You may be in the wrong mode. Press ■ [MODES] ALG to set Algebraic mode.

Q: How do I change the number of decimal places the HP-19B displays?

A: The procedure is described in "Changing the Number of Displayed Decimal Places" on page 34.

Q: How do I clear all or portions of memory?

A: ■ [CLEAR] clears the calculator line. ■ [CLEAR DATA] clears various portions of memory, depending on which menu the HP-19B is displaying. (Look up [CLEAR DATA] in the index for a list of page references.) Erasing the entire contents of memory is covered in "Erasing Continuous Memory" on page 276.

Q: Why am I getting the wrong answer using the TVM menu?

A: Before beginning a TVM calculation, be sure to clear the TVM variables (■ [CLEAR DATA]), set the appropriate payment mode (mortgages and loans are typically End mode calculations), and specify the number of payments per year (P/YR).

Q: Can I use the TVM menu with the Solver?

A: No, but you can use the TVM Solver functions to do the same calculations (see page 238).

Q: How do I indicate multiplication in a Solver equation?

A: You must use the multiplication sign ([×]) on the right side of the keyboard. You *cannot* use the [X] letter key to indicate multiplication.

Q: Why isn't the beeper working?

A: The beeper is turned off (see page 36).

Q: My numbers contain commas instead of periods as decimal points. How do I restore the periods?

A: Changing the decimal point is covered in "Interchanging the Period and Comma in Numbers" on page 35.

Q: What does an "E" in a number (for example, 2.51E-13) mean?

A: The number is very large or very small. Refer to "Scientific Notation" on page 48.

Q: The calculator has displayed the message INSUFFICIENT MEMORY. What should I do?

A: Refer to "Managing Calculator Memory" on page 274 for instructions on how to reclaim memory for your use.

Q: The calculator is operating more slowly than usual, and the annunciator is blinking. Why?

A: The calculator is in trace mode for printing. Press [PRINTER] TRACE [EXIT] to turn off tracing.

Q: How can I change the sign of a number in a list without keying in the number again?

A: Position the list pointer at the number and press [RCL] [INPUT] [+/-] [INPUT].

Q: Why does calculating the sine of π radians display a very small number instead of 0?

A: π cannot be represented *exactly* with the 12-digit precision of the calculator.

Q: Why do I get incorrect answers when I use the trigonometric functions?

A: You must make sure you are in the correct trigonometric mode (see page 51.)

Power and Batteries

The HP-19B is powered by three alkaline batteries. A fresh set of batteries typically will provide approximately six months to one year of use. However, expected battery life depends on how the calculator is used. Printing requires more power than other operations.

Use only fresh N-cell alkaline batteries. Do not use rechargeable batteries.

Low Power Indicator

When the low battery annunciator ( ) comes on, the HP-19B can continue operating for several hours of normal use. If the calculator is turned off, Continuous Memory will be preserved for approximately one month.

If you continue to use the calculator after the battery annunciator comes on, power can eventually drop to a level at which the calculator stops powering the display and keyboard. The calculator will require fresh batteries before it can be turned on. When you turn the calculator on after fresh batteries have been installed, the HP-19B displays MACHINE RESET if your stored data is intact. If data has been lost, the HP-19B displays MEMORY LOST. In either case, the clock may be incorrect.

Installing Batteries

Once the battery compartment is open, you must replace the batteries and close the compartment within one minute to prevent loss of Continuous Memory. Therefore, you should have the new batteries readily at hand before opening the battery compartment. Also, you must make sure the calculator is off during the entire process of changing batteries.

To install batteries:

1. Have three fresh N-cell batteries readily at hand.
2. Open the calculator to expose the keyboard and display. If you are replacing batteries, make sure the calculator is off. **Do not press [ON] until the entire procedure for changing batteries is completed. Changing batteries with the calculator on could erase the contents of Continuous Memory.** (If you have any pending alarms stored in memory, check to make sure no alarm will come due while the batteries are out.)
3. Hold the calculator with the battery compartment door facing up. To remove the battery compartment door, slide it towards the back of the calculator (away from the product label).

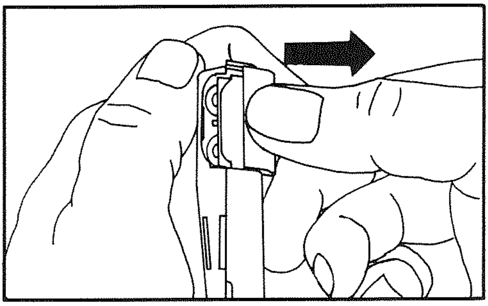


Figure A-1. Removing the Battery Compartment Door

4. Tip the calculator to remove the old batteries. You may have to hit the calculator against your hand to dislodge the last battery.
5. Insert three new batteries. Orient the batteries as shown on the diagram on the back of the calculator. Be certain to observe the polarities (+ and −) as shown.
6. Press the batteries into the compartment using the portion of the battery door that extends beyond the metal contact plate. Press down until the contact plate is lined up with the grooves on the calculator case.

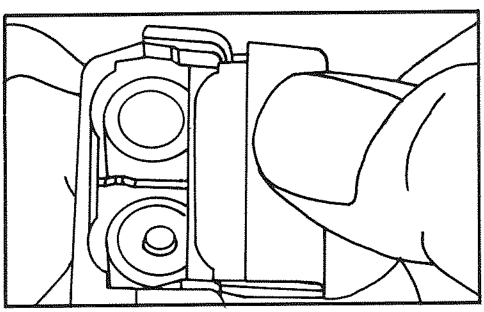


Figure A-2. Pressing the Batteries Into Place

7. Slide the contact plate into the grooves. If necessary, use your finger to push the batteries into the compartment so that the door can slide over them. Pressing firmly, slide the door until it latches into place.

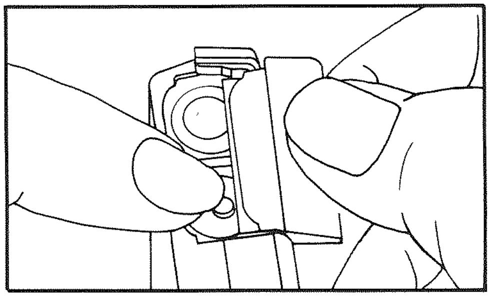


Figure A-3. Closing the Battery Compartment Door

Warning **Do not mutilate, puncture, or dispose of batteries in fire. The batteries can burst or explode, releasing hazardous chemicals.**

Memory Loss Due to Low Power

If battery power ever gets so low that Continuous Memory is lost, or if power is otherwise interrupted, the HP-19B displays the INTL (international) menu when power is restored. You must specify a language before proceeding (see page 20 for information about the setting the language).

Managing Calculator Memory

The HP-19B has approximately 6,600 units (or "bytes") of calculator memory available for your use. Table A-1 describes the amount of memory used by the various types of information you can store. Built-in variables and built-in formulas are not listed; space is allocated to them elsewhere in calculator memory.

The message INSUFFICIENT MEMORY informs you that you are attempting to do an operation that uses more calculator memory than is currently available. Here are some suggestions for dealing with this situation:

1. Whenever the message is displayed, you should complete any arithmetic calculations you were in the process of doing in the calculator line (press [=] or [■][CLEAR]).
2. To further reduce the amount of occupied memory, you can:
   - Delete any Solver variables you no longer need.
   - Delete any equations you no longer need.
   - Clear any SUM, CFLO, and TEXT lists you no longer need.
   - Delete any TEXT entries you no longer need.
   - Delete unneeded individual and global labels from your SUM lists.
   - Rename any named equations and SUM, CFLO, and TEXT lists to shorter names.
   - Shorten or delete any appointment messages.

Table A-1. Memory Requirements

Type of Information	Amount of Memory Used
CFLO lists (excluding the list name)	8 bytes per list + 9½ bytes for each flow entry (flow amount and #TIMES).
SUM lists (excluding labels and names)	41 bytes per list + 8 bytes for each item.
SUM local labels	10 bytes per label.
TEXT lists	10 bytes + 8½ bytes per entry + 1 byte for each character (record marker characters do not require 1 byte each).
List names	1 byte + 1 byte for each character in the name..
Solver equations *	8½ bytes per equation + 1 byte for each character in the equation (including spaces and the equation name) + 1 byte for each character in the equation name.
Solver variables	15 bytes for each variable + 1 byte for each character in the variable name.
Calculator line	Numbers: 8 bytes + 1 byte for each character Operators: 3½ bytes.
Appointment messages	31 bytes for the first message stored + 1 byte for each character in each message.

* Displaying the menu of variables of a Solver equation substantially increases its memory requirements.

Resetting the Calculator

If the calculator fails to respond to keystrokes or if it is otherwise behaving unusually, you should attempt to reset it. Resetting the calculator halts the current calculation, clears the calculator line, and displays the MAIN menu. Stored data remains intact.

To reset the calculator, hold down the [ON] key while you press the third menu key from the left. It may be necessary to repeat the reset keystrokes several times. The HP-19B displays MACHINE RESET to confirm that reset has occurred. If you are unable to reset the calculator, try installing fresh batteries. If the calculator still fails to operate properly, you should attempt to erase Continuous Memory.

A MACHINE RESET can occur automatically if the calculator is dropped or if power is interrupted.

Erasing Continuous Memory

Erasing Continuous Memory is a way of freeing a large amount of memory so that you can use it for other things. In addition, the calculator is set to certain "default" settings.

Erasing Continuous Memory:

- Clears the calculator line and history stack.
- Clears all values stored in built-in variables.
- Deletes all equations you've entered into the Solver, and their variables.
- Clears all SUM, CFLO, and TEXT lists, including their names.
- Clears all appointments.
- Sets these conditions: month/day/year date format, 12-hour time format, 2 decimal places (FIX 2), period (.) decimal point, beeper on, Degrees mode, printer tracing off, printer without ac adapter, and Double Space mode off.
- Maintains the selected mode—ALG or RPN.

Erasing Continuous Memory does not affect the current time and date or language.

To erase Continuous Memory:

1. Press and hold down the [ON] key.
2. Press and hold down the leftmost menu key.
3. Press the rightmost menu key. (You will be pressing three keys simultaneously).

When the three keys are released, the HP-19B displays

```
MEMORY LOST
```

If the calculator fails to respond to keystrokes and you are unable to restore operation by performing a reset operation or by changing the batteries, erasing Continuous Memory may restore calculator function.

Continuous Memory may inadvertently be erased if the calculator is dropped or if power is interrupted. If `MEMORY LOST` occurs automatically, the calculator displays the INTL menu the next time it is turned on.

Calculator Maintenance

To clean the display, use a cloth slightly moistened with water. Avoid getting the calculator wet.

Do not lubricate the hinge.

Clock Accuracy

The system clock is regulated by a quartz crystal accurate to within three minutes per month for normal operating temperatures. The accuracy of the clock crystal is affected by temperature, physical shock, humidity, and aging. Optimum accuracy is maintained at 25°C (77°F).

Environmental Limits

In order to maintain product reliability, you should observe the following temperature and humidity limits of the HP-19B:

- Operating temperature: 0° to 45°C (32° to 113°F).
- Storage temperature: −20° to 65°C (−40° to 149°F).
- Operating and storage humidity: 90% relative humidity at 40°C (104°F) maximum.

Determining If the Calculator Requires Service

Use these guidelines to determine if the calculator requires service. If these procedures confirm that the calculator is not functioning properly, read the section "If the Calculator Requires Service" on page 281.

- **If the calculator won't turn on (nothing is visible in the display):**
  1. Attempt to reset the calculator (see page 275).
  2. If the calculator fails to respond after step 1, replace the batteries (see page 271).

  If steps 1 and 2 do not restore the display, the calculator requires service.

- **If the calculator doesn't respond to keystrokes (nothing happens when you press any of the keys):**
  1. Attempt to reset the calculator (see page 275).
  2. If the calculator fails to respond after step 1, attempt to erase Continuous Memory (see page 276). This will erase all the information you've stored.
  3. If steps 1 and 2 fail to restore calculator function, the calculator requires service.

- **If the calculator responds to keystrokes but you suspect that it is malfunctioning:**
  1. Do the self-test (described below). If the calculator fails the self test, it requires service.
  2. If the calculator passes the self-test, it is quite likely that you've make a mistake in operating the calculator. Try rereading portions of the manual, and check "Answers to Common Questions" on page 268.
  3. Contact the Calculator Support department. The address and phone number are listed on the inside back cover.

Confirming Calculator Operation—the Self-Test

If the display can be turned on, but it appears that the calculator is not operating properly, you can do a diagnostic self-test. To run the self-test:

1. Turn the calculator on.
2. If you have the optional printer, turn it on. Certain diagnostic information will be printed as the test proceeds.
3. If possible, return to the MAIN menu by pressing ■ [MAIN].
4. To start the self-test, hold down the [ON] key while you press the fifth menu key from the left.* Once the self-test has begun, do not press any keys until you are ready to halt the test. The HP-19B displays a series of patterns. You should watch for one of two messages. They are displayed briefly, before the test automatically repeats.
   - If the calculator passes the self-test, the HP-19B displays `OK- 19B II.`
   - If the HP-19B displays a number followed by `FAIL`, the calculator may require service.
5. To halt the self-test, hold down [ON] while you press the third menu key from the left. The HP-19B displays `MACHINE RESET`. If you press any other key instead, the test halts and the HP-19B displays a `FAIL` message. *This message results from an incorrect key being pressed, and does not mean that the calculator requires service.*
6. If the HP-19B failed the self-test, you should repeat steps 4 and 5 to verify the results.

* Pressing the fourth menu key from the left starts another self-test that is used at the factory. If you accidently start this self-test, you can stop it by holding down the [ON] key while you press the third menu key from the left.

Limited One-Year Warranty

What Is Covered

The calculator (except for the batteries, or damage caused by the batteries) *is warranted by Hewlett-Packard against defects in materials and workmanship for one year from the date of original purchase.* If you sell your unit or give it as a gift, the warranty is automatically transferred to the new owner and remains in effect for the original one-year period. During the warranty period, we will repair or, at our option, replace at no charge a product that proves to be defective, provided you return the product, shipping prepaid, to a Hewlett-Packard service center. (Replacement may be with a newer model of equivalent or better functionality.)

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

What Is Not Covered

Batteries, and damage caused by the batteries, are not covered by the Hewlett-Packard warranty. Check with the battery manufacturer about battery and battery leakage warranties.

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

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

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

Consumer Transactions in the United Kingdom

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

If the Calculator Requires Service

Hewlett-Packard maintains service centers in many countries. These centers will repair a calculator, or replace it with the same model or one of equivalent or greater value, whether it is under warranty or not. There is a service charge for service after the warranty period. Calculators normally are serviced and reshipped within 5 working days.

Obtaining Service

- **In the United States:** Send the calculator to the Corvallis Service Center listed on the inside of the back cover.
- **In Europe:** Contact your HP sales office or dealer, or HP's European headquarters for the location of the nearest service center. *Do not ship the calculator for service without first contacting a Hewlett-Packard office.*

Hewlett-Packard S.A.
150, Route du Nant-d'Avril
P.O. Box
CH 1217 Meyrin 2
Geneva, Switzerland
Telephone: (22) 780.81.11

- **In other countries:** Contact your HP sales office or dealer or write to the Corvallis Service Center (listed on the inside of the back cover) for the location of other service centers. If local service is unavailable, you can ship the calculator to the Corvallis Service Center for repair.

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

Service Charge

There is a standard repair charge for out-of-warranty service. The Corvallis Service Center (listed on the inside of the back cover) can tell you how much this charge is. The full charge is subject to the customer's local sales or value-added tax wherever applicable.

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

Shipping Instructions

If your calculator requires service, ship it to the nearest authorized service center or collection point. (You must pay the shipping charges for delivery to the service center, whether or not the calculator is under warranty.)

- Include your return address and description of the problem.
- Include proof of purchase date if the warranty has not expired.
- Include a purchase order, check, or credit card number plus expiration date (VISA or MasterCard) to cover the standard repair charge.
- Ship the calculator in adequate protective packaging to prevent damage. Such damage is not covered by the warranty, so we recommend that you insure the shipment.
- Pay the shipping charges for delivery to the Hewlett-Packard service center, whether or not the calculator is under warranty.

Warranty on Service

Service is warranted against defects in materials and workmanship for 90 days from the date of service.

Service Agreements

In the U.S., a support agreement is available for repair and service. Refer to the form in the front of the manual. For additional information, contact the Corvallis Service Center (see the inside of the back cover).

Regulatory Information

Radio Frequency Interference

U.S.A. The HP-19B generates and uses radio frequency energy and may interfere with radio and television reception. The calculator complies with the limits for a Class B computing device as specified in Subpart J of Part 15 of FCC Rules, which provide reasonable protection against such interference in a residential installation. In the unlikely event that there is interference to radio or television reception (which can be determined by turning the HP-19B off and on or by removing the batteries), try:

- Reorienting the receiving antenna.
- Relocating the calculator with respect to the receiver.

For more information, consult your dealer, an experienced radio/television technician, or the following booklet, prepared by the Federal Communications Commission: *How to Identify and Resolve Radio-TV Interference Problems.* This booklet is available from the U.S. Government Printing Office, Washington, D.C. 20402, Stock Number 004-000-00345-4. At the first printing of this manual, the telephone number was (202) 783-3238.

West Germany. The HP-19B and the HP 82240 printer comply with VFG 1046/84, VDE 0871B, and similar non-interference standards.

If you use equipment that is not authorized by Hewlett-Packard, that system configuration has to comply with the requirements of Paragraph 2 of the German Federal Gazette, Order (VFG) 1046/84, dated December 14, 1984.

Air Safety Notice (U.S.A.)

The HP-19B and the HP 82240 printer comply with the requirements of RTCA (Radio Technical Commission for Aeronautics) Docket 160B, Section 21. Many airlines permit the use of calculators in flight based on such a qualification. However, before boarding a flight, check with an airline representative regarding use of calculators in flight.

B

More About HP-19B Calculations

IRR% Calculations

The HP-19B calculates *IRR%* for a set of cash flows using mathematical equations that "search" for the answer. The process finds a solution by estimating an answer and then using that estimate to do another calculation—in mathematical terms, an iterative process.

In most cases, the HP-19B finds the unique *IRR%* if it exists. However, calculating *IRR%* for certain sets of cash flows is more complex. There may be more than one mathematical solution to the problem, or there may be no solution. In these cases, the HP-19B displays a message to help you interpret what has happened.

Possible Outcomes of Calculating IRR%

These are the possible outcomes of an *IRR%* calculation for which you have not stored a guess. Storing a guess is covered on page 286.

- **Case 1:** The HP-19B displays a positive answer. This is the only positive answer. However, one or more negative answers may exist.
- **Case 2:** The HP-19B displays a negative answer and the message:

  ```
  IRR%>0 EXISTS; TO SEEK:
  INPUT GUESS [STO](IRR%)
  ```

  The HP-19B has detected that there is a single positive answer. To search for that positive answer, you must input a guess (see "Storing a Guess for IRR%" on page 286). There may also be one or more additional negative answers.

- **Case 3:** The HP-19B displays a negative answer and no message. This is the only answer.
- **Case 4:** The HP-19B displays:

  ```
  MANY OR NO SOLUTIONS;
  INPUT GUESS [STO]{IRR%}
  ```

  The calculation is very complex. It may involve more than one positive and/or negative answer or there may be no solution. To continue the calculation, you must store a guess (see "Storing a Guess for IRR%, below).
- **Case 5:** There is no answer. The HP-19B displays `NO SOLUTION`. This situation may have been caused by a mistake made in keying in the cash flows. Review the list for typing mistakes or incorrect signs. One thing to look for is a mistake in entering the sign of a cash flow. There can be no solution without at least one positive *and* one negative cash flow.

Halting and Restarting the IRR% Calculation

The search for *IRR%* may take a relatively long time. You can halt the calculation at any time by pressing any key. The HP-19B then displays the current estimate for *IRR%*. You can resume the calculation by:

- Pressing [STO] IRR% while the current estimate is displayed in the calculator line. This continues the calculation from where it left off.
- Storing a guess for *IRR%*, discussed below.

Storing a Guess for IRR%

You can enter a guess for *IRR%* at these times:

- Before beginning the *IRR%* calculation. If you have some idea what the answer should be, this may reduce the time required to calculate an answer.
- After you've halted the *IRR%* calculation.

- After the HP-19B has halted the calculation due to any of the cases listed above. For cases 3 and 5, however, no (other) solutions will be found.

To enter a guess, key in an estimate of *IRR%* and press [STO] IRR% .

When it is calculating *IRR%* using a guess you've entered, the HP-19B displays the current estimate of *IRR%* and the calculated value of *NPV* for each iteration. The calculation halts when the HP-19B finds an answer near your guess. However, there may be additional positive or negative answers or there may be no solution. You can continue searching for other solutions by halting the calculation and entering a different guess.

Choosing a Guess for IRR%. There are two ways to find a good guess for *IRR%*. Both ways are based on the definition of *IRR%*; *IRR%* is the interest rate (*I%*) at which *NPV* equals 0:

- Press PLOT in the CFLO menu to plot *NPV* versus *I%* for the current CFLO list. Position the graphics cursor at the intersection(s) of the plot and the horizontal axis, and use the *I%* value at the intersection as a guess for *IRR%*. (See page 125 for additional information about PLOT).
- Use the CFLO CALC menu to calculate *NPV* for various interest rates (*I%*). The best guess of *IRR%* is the interest rate that yields the value for *NPV* closest to 0. For each interest rate:

  1. Key in the interest rate (an estimate for *IRR%*) and press I% .
  2. Press NPV to calculate *NPV* for that interest rate.

  Repeat the calculation of *NPV* for several values of *I%*, and look for trends in the results. Choose as your guess for *IRR%* the value of *I%* that produces an *NPV* closest to 0.

Solver Calculations

In most cases, the Solver calculates and displays the answer to your problem, because there is only one correct answer and the equation is easy for the Solver to interpret. However, the Solver is capable of handling a wide variety of complex mathematical conditions. In order for you to use all the calculating power included in the Solver, it will be helpful to you to understand, in a general way, how it works.

Direct Solutions

When you start a calculation (by pressing a menu key), the Solver first tries to find a *direct* solution by "isolating" the variable you are solving for (frequently called the "unknown"). Isolating a variable involves rearranging the equation so that the unknown variable is by itself on the left-hand side of the equation. For example, if you enter the equation:

```
PROFIT = PRICE-COST
```

and solve for *COST* (*COST* is the unknown), the Solver uses rules of algebra to internally rearrange the equation to:

$$COST = PRICE - PROFIT$$

After you've stored values for *PROFIT* and *PRICE*, pressing COST causes the Solver to use the rearranged equation to calculate an answer. Answers calculated this way are called direct solutions.

For certain equations, the unknown can be isolated, but an answer cannot be calculated with the values you store. Then, the HP-19B displays:

```
SOLUTION NOT FOUND
```

For example, if you enter the equation:

```
AREA = L×W
```

and then enter values for *AREA* and *W*, the Solver rearranges the equation to:

$$L = AREA \div W$$

in order to calculate *L*. However, if you enter the value 0 for *W*, the Solver cannot find an answer because division by zero is not allowed.

Requirements for a Direct Solution. The Solver can isolate the unknown variable if the equation meets these conditions:

- The only operators involving the unknown are +, −, ×, ÷, and ^.*
- The unknown is not an exponent.
- The unknown occurs only once in the equation. There are two exceptions:
  1. Occurrences of the unknown in the S function can be ignored.
  2. The variable is counted as appearing only once within an IF function if it appears only once in each of the algebraic expressions.
- The unknown does not appear in the conditional expression in an IF function, except in the S function.
- The unknown does not appear in any of these functions: †

ABS	IP	SGN
COMB	MAX	SPFV
FACT	MIN	SPPV
FP	MOD	TRN
IDIV	PERM	USFV
INT	RND	USPV

* When the unknown is raised to a positive even power, there may be more than one solution. The Solver finds one of the solutions using the positive root. For example, the Solver rearranges `(X-1)^2=25` to $X - 1 = 5$ and calculates $X = 6$. To find the other solution ($X = -4$), the equation can be rewritten `(1-X)^2=25`.

† When the unknown is in an angle function (for example, SIN, XCOORD), there is usually an infinite number of solutions. A direct solution finds one solution. For example, `TAN(A)=1` has solutions $A = 45° \pm 180 \times n$, $n = 0, 1, 2, \ldots$. The Solver rearranges this equation to A=ATAN(1) and calculates $A = 45°$. If the equation is rewritten `TAN(A-180)=1`, it is rearranged to A = ATAN(1) + 180, and $A = 225°$.

- The unknown does not appear as *cal* in the DDAYS function, or as *#p/yr* or *m* in any of the TVM functions.

Iterative Solutions

If the Solver is not able to isolate the unknown variable, it cannot provide a direct solution. In these cases, the Solver searches for an iterative solution.*

In its search for an iterative solution, the Solver is looking for a value that sets the left-hand side of the equation equal to the right-hand side. To do this, the Solver first uses two initial estimates of the answer, which we'll call estimate #1 and estimate #2. Using estimate #1, the Solver calculates values for the left and right side of the equation (*LEFT* and *RIGHT*) and calculates *LEFT* minus *RIGHT* (*LEFT*−*RIGHT*). Then, the Solver does the same calculations for estimate #2. If neither estimate produces a value of 0 for *LEFT*−*RIGHT*, the Solver analyzes the results of its calculations and produces two new estimates that it judges to be closer to the answer. By repeating this process many times, the Solver narrows in on the answer. During the search for an iterative solution, the HP-19B displays the two current estimates and the sign of *LEFT*−*RIGHT* for each estimate (see figure B-1).

* An iterative solution can be "forced" by appending *unknown*−*unknown*+ to the beginning of the equation. For example, `A-A+TAN(A)=1` will be solved iteratively, and different solutions can be found by entering appropriate guesses. The Solver's ability to find an iterative solution can often be enhanced by rewriting the equation so that the unknown variable does not appear as a divisor. For example, the Solver may more easily solve for A if the equation `1÷(A^2-A)=B` is rewritten as `(A^2-A)×B=1`.

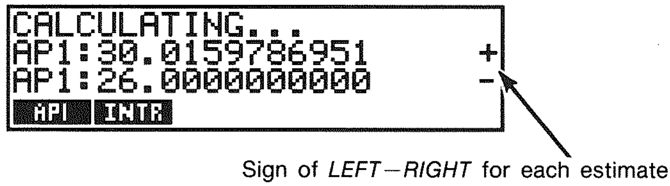


Figure B-1. Displaying the Current Estimates During Iteration

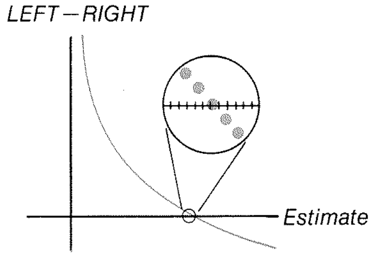
Since calculators cannot do calculations with infinite precision (the HP-19B uses 12 digits in its calculations), sometimes the Solver will be unable to find an estimate where *LEFT—RIGHT* is exactly 0. However, the Solver can distinguish between situations where the current estimate *may* be a solution, and situations where the Solver cannot find a solution.

The search for an iterative solution can sometimes take several minutes. (You can halt the search at any time by pressing any key.) There are four possible outcomes for an iterative solution:

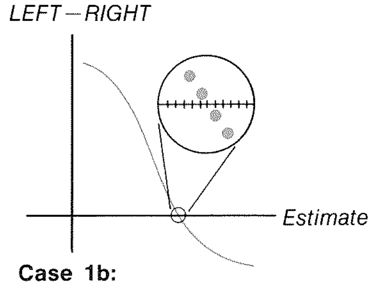
- **Case 1:** The HP-19B displays an answer on line 3 and there is no message in lines 1 and 2. It is very likely that the answer on line 3 is a solution for the unknown variable.

  There are two situations in which the Solver returns a case 1 answer (see figure B-2):

  - **Case 1a:** *LEFT—RIGHT* is exactly 0.
  - **Case 1b:** *LEFT—RIGHT* is not zero for either estimate. However, the Solver has found two estimates that cannot get any closer together. (Numbers that are as close together as possible are called "neighbors.") Furthermore, *LEFT—RIGHT* is a positive value for one estimate and a negative value for the other estimate.



Case 1a:
LEFT−RIGHT is exactly 0.



Case 1b:
LEFT−RIGHT is not exactly 0. *LEFT* and *RIGHT* are relatively close together. The two estimates are "neighbors".

Figure B-2. Iterative Solutions—Case 1

If you want to know whether *LEFT−RIGHT* is *exactly* 0, press the menu key for the unknown variable. If *LEFT−RIGHT* is *not* equal to 0, the HP-19B displays the values of *LEFT* and *RIGHT* on lines 1 and 2.

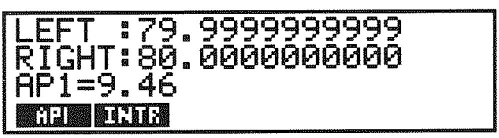


Figure B-3. Displaying *LEFT* and *RIGHT*

The equation could have more than one iterative solution. If the answer does not seem reasonable, you should enter one or two guesses and restart the search.

- **Case 2:** The HP-19B displays an answer on line 3 and automatically displays the values of *LEFT* and *RIGHT* on lines 1 and 2. The answer on line 3 *could be* a solution for the variable. If *LEFT* and *RIGHT* are relatively close to one another in value, the answer is probably a solution. Otherwise, the answer is probably not a solution.

  If the answer in line 3 seems unreasonable, it could be because the equation has more than one iterative solution. You might want to enter one or two guesses and restart the search.

If you want to obtain additional information about the answer, press and hold down the menu key for the unknown variable until the numbers in the display stop changing. At this point, the Solver is displaying the final estimates and the signs of *LEFT−RIGHT* for each estimate.

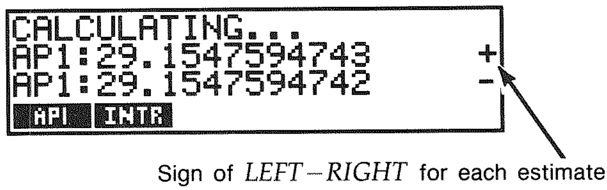
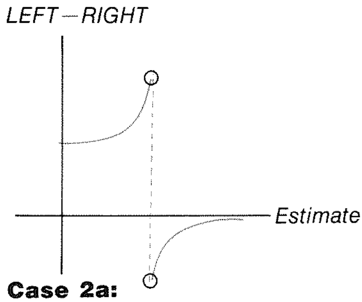


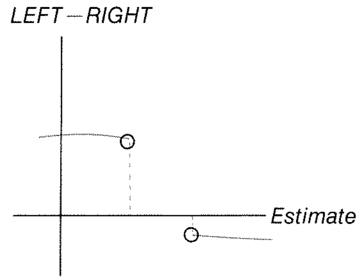
Figure B-4. Displaying the Final Estimates and Signs of *LEFT−RIGHT*

This information can be helpful (see figure B-5):

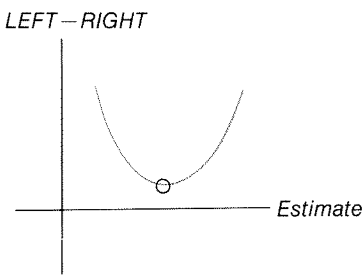
- **Case 2a:** If the signs of *LEFT−RIGHT* are opposite, and the two estimates are as close together as two 12-digit numbers can get (neighbors), the Solver found two estimates that "bracketed" an ideal solution (a solution where *LEFT−RIGHT* equals 0). If *LEFT* and *RIGHT* are relatively close together, the answer is probably a solution. Otherwise, the answer is probably not a solution.
- **Case 2b:** If the signs of *LEFT−RIGHT* are opposite, and the two estimates are not neighbors, you should be very cautious about accepting the answer as a solution. If *LEFT* and *RIGHT* are relatively close together, the answer is probably a solution.
- **Case 2c:** If *LEFT−RIGHT* for the the two estimates have the same sign, the Solver has halted because it could find no estimates that further reduced the magnitude of *LEFT−RIGHT*. You should be very cautious about accepting the answer. If the values of *LEFT* and *RIGHT* are not relatively close to one another, you should reject the answer as a solution.



Case 2a:
LEFT—RIGHT have opposite signs. The two estimates are "neighbors".



Case 2b:
LEFT—RIGHT have opposite signs. The two estimates are not "neighbors".



Case 2c:
LEFT—RIGHT have the same sign.

Figure B-5: Iterative Solutions—Case 2

- **Case 3:** The HP-19B displays:

  `TRY AGAIN, BAD GUESSES:`

  This indicates that the Solver is unable to begin its search for an iterative solution using the current initial estimates (guesses). There may be a solution you can find by entering different estimates. The closer you can estimate the answer, the more likely it is that the Solver will find a solution.

- **Case 4:** The HP-19B displays:

  `SOLUTION NOT FOUND`

  This message indicates that the Solver is unable to make any progress towards finding a solution. You should check your equation to make sure you have made no errors in entering it. Also check the values of each of the known variables. If your equation and variables are correct, you *may* be able to find a solution by entering very good guesses.

Equations Used by HP-19B Menus

Actuarial Functions

n = number of compounding periods.
$i\%$ = periodic interest rate, expressed as a percentage.

Single Payment Present Value Function
(Present value of a single $1.00 payment made after n periods.)

$$SPPV\ (i\%{:}n) = \left(1 + \frac{i\%}{100}\right)^{-n}$$

Single Payment Future Value Function
(Future value after n periods of a single $1.00 payment.)

$$SPFV\ (i\%{:}n) = \left(1 + \frac{i\%}{100}\right)^{n}$$

Uniform Series Present Value Function
(Present value of a $1.00 payment that occurs n times.)

$$USPV\ (i\%{:}n) = \frac{1 - \left(1 + \frac{i\%}{100}\right)^{-n}}{\frac{i\%}{100}}$$

Uniform Series Future Value Function
(Future value of a \$1.00 payment that occurs n times.)

$$USFV\ (i\%{:}n) = \frac{\left(1 + \dfrac{i\%}{100}\right)^n - 1}{\dfrac{i\%}{100}}$$

Business Percentages

$$\%CHANGE = \left(\frac{NEW - OLD}{OLD}\right) \times 100$$

$$\%TOTAL = \left(\frac{PART}{TOTAL}\right) \times 100$$

$$MARKUP\%C = \left(\frac{PRICE - COST}{COST}\right) \times 100$$

$$MARKUP\%P = \left(\frac{PRICE - COST}{PRICE}\right) \times 100$$

Currency Exchange

$$CURR1 = \frac{CURR2}{RATE}$$

Unit Conversions

Length, Area, Volume, and Mass. The relationship between any unit (*unit'*) of length, area, volume, or mass and the *base unit* is defined as follows:

$$1\ unit' = \{conversion\ factor\}\ base\ unit$$

The base units are:

Length: meters
Area: square meters
Volume: cubic meters
Mass: kilograms

To calculate the conversion factor between *unit'* and the *base unit*:

1. Key in 1 and press the menu key for *unit'*.
2. Press the menu key for the base unit.

For example, the keystrokes 1 CM M displays METERS=0.01. Therefore, the relationship between centimeters and the base unit meters is 1 centimeter = 0.01 meters.

Temperature

$°F = \frac{9}{5}°C + 32$

$°K = °C + 273.15$

$°R = °F + 459.67$

Time Value of Money (TVM)

S = payment mode factor (0 for End mode; 1 for Begin mode).

$$i\% = \frac{I\%YR}{P/YR}$$

$$0 = PV + \left(1 + \frac{i\% \times S}{100}\right) \times PMT \times USPV\,(i\%{:}n) + FV \times SPPV\,(i\%{:}n)$$

Amortization

ΣINT = accumulated interest
$\Sigma PRIN$ = accumulated principal
i = periodic interest rate
BAL is initially PV rounded to the current display setting.
PMT is initially PMT rounded to the current display setting.

$$i = \frac{I\%YR}{P/YR \times 100}$$

For each payment amortized:

INT' is rounded to the current display setting; $INT' = 0$ for period 0 in Begin mode

$$INT' = BAL \times i$$

$$INT = INT' \text{ (with sign of } PMT\text{)}$$

$$PRIN = PMT + INT'$$

$$BAL_{new} = BAL_{old} + PRIN$$

$$\Sigma INT_{new} = \Sigma INT_{old} + INT$$

$$\Sigma PRIN_{new} = \Sigma PRIN_{old} + PRIN$$

Interest Rate Conversions

Periodic compounding

$$EFF\% = \left[\left(1 + \frac{NOM\%}{100 \times P}\right)^{P} - 1\right] \times 100$$

Continuous compounding

$$EFF\% = \left(e^{\frac{NOM\%}{100}} - 1\right) \times 100$$

Cash Flow Calculations

j = the group number of the cash flow.
CF_j = amount of the cash flow for group j.
n_j = #TIMES the cash flow occurs for group j.
k = the group number of the last group of cash flows.

$$N_j = \sum_{1 \leq l < j} n_l = \textit{total number of cash flows prior to group } j$$

$$NPV = CF_0 + \sum_{j=1}^{k} (CF_j \times \text{USPV}\ (i\%:n_j) \times \text{SPPV}\ (i\%:N_j))$$

When $NPV = 0$, the solution for $i\%$ is $IRR\%$.

$$NFV = NPV \times \text{SPFV}\ (i\%:N) \text{ where } N = \sum_{j=1}^{k} n_j$$

$$NUS = \frac{NPV}{\text{USPV}\ (i\%:N)}$$

$$TOTAL = \sum_{j=0}^{k} (n_j \times CF_j)$$

Bond Calculations

Reference: Lynch, John J., Jr. and Jan H. Mayle, *Standard Securities Calculation Methods*, Securities Industry Association, New York, 1986.

A = accrued days, the number of days from beginning of coupon period to settlement date.
E = number of days in coupon period bracketing settlement date. By convention, E is 180 (or 360) if the calendar basis is 30/360.
DSC = number of days from settlement date to next coupon date. ($DSC = E - A$).
M = coupon periods per year (1 = annual, 2 = semiannual).
N = number of coupon periods between settlement and redemption dates. If N has a fractional part (settlement not on coupon date), then round it to the next higher whole number.
Y = annual yield as a decimal fraction, $YLD\%$ / 100.

For one or fewer coupon period to redemption:

$$PRICE = \left[\frac{CALL + \frac{CPN\%}{M}}{1 + \left(\frac{DSC}{E} \times \frac{Y}{M} \right)} \right] - \left(\frac{A}{E} \times \frac{CPN\%}{M} \right)$$

For more than one coupon period to redemption:

$$PRICE = \left[\frac{CALL}{\left(1 + \frac{Y}{M}\right)^{N-1+\frac{DSC}{E}}} \right]$$

$$+ \left[\sum_{K=1}^{N} \frac{\frac{CPN\%}{M}}{\left(1 + \frac{Y}{M}\right)^{K-1+\frac{DSC}{E}}} \right] - \left(\frac{A}{E} \times \frac{CPN\%}{M} \right)$$

$$ACCRU = \frac{A}{E} \times \frac{CPN\%}{M}$$

The "end-of-month" convention is used to determine coupon dates in the following exceptional situations. (This affects calculations for *YLD%*, *PRICE*, and *ACCRU*.)

- If the maturity date falls on the last day of the month, the coupon payments also fall on the last day of the month. For example, a semiannual bond that matures on September 30 has coupon payment dates on March 31 and September 30.
- If the maturity date of a semiannual bond falls on August 29 or 30, the February coupon payment dates falls on the last day of February (28 or 29).

Depreciation Calculations

For the given year, *YR#*:

$$ACRS = \frac{ACRS\%}{100} \times BASIS$$

$$SL = \frac{BASIS - \text{SALV}}{LIFE}$$

$$SOYD = \frac{BASIS - SALV}{LIFE \times \dfrac{(LIFE + 1)}{2}} \times (LIFE - YR\# + 1)$$

$$DB = \frac{BASIS \times FACT\%/100}{LIFE} \times \left(1 - \frac{(FACT\%/100)}{LIFE}\right)^{(YR\# - 1)}$$

$$RDV = BASIS - SALV - \text{accumulated depreciation}$$

For the last year of depreciation, *DB* equals the remaining depreciable value for the prior year.

Values of *DB*, *SOYD*, *SL*, and *RDV* are rounded to the current display setting.

Sum and Statistics

n = number of items in the list.
x' = an element of the sorted list.

$$TOTAL = \Sigma x_i \qquad MEAN = \bar{x} = \frac{\Sigma x_i}{n}$$

$$MEDIAN = x_j' \text{ for odd } n, \text{ where } j = \frac{n + 1}{2}$$

$$MEDIAN = \frac{(x_j' + x_{j+1}')}{2} \text{ for even } n, \text{ where } j = \frac{n}{2}$$

$$STDEV = \sqrt{\frac{\Sigma (x_i - \bar{x})^2}{n - 1}}$$

$$W.MN = \frac{\Sigma\ (y_i\ x_i)}{\Sigma y_i} \qquad G.SD = \sqrt{\frac{\Sigma y_i\ x_i^2 - (\Sigma y_i)\ \bar{x}^2}{(\Sigma y_i) - 1}}$$

$$RANGE = MAX - MIN$$

Forecasting

Model		Transformation	X_i	Y_i
LIN	$y = B + Mx$	$y = B + Mx$	x_i	y_i
EXP	$y = Be^{Mx}$	$\ln y = \ln B + Mx$	x_i	$\ln y_i$
LOG	$y = B + M \ln x$	$y = B + M \ln x$	$\ln x_i$	y_i
PWR	$y = Bx^M$	$\ln y = \ln B + M \ln x$	$\ln x_i$	$\ln y_i$

Let: $$\overline{X} = \frac{\Sigma X_i}{n} \qquad \overline{Y} = \frac{\Sigma Y_i}{n}$$

$$SX2 = \Sigma (X_i - \overline{X})^2 \qquad SY2 = \Sigma (Y_i - \overline{Y})^2$$

$$SXY = \Sigma (X_i - \overline{X})\ (Y_i - \overline{Y})$$

Then: $$M = \frac{SXY}{SX2}$$

$$B = \begin{cases} \overline{Y} - M\ \overline{X};\ LIN,\ LOG \text{ models} \\ e^{Y-MX};\ EXP,\ PWR \text{ models} \end{cases}$$

$$\text{CORR} = \frac{SXY}{\sqrt{SX2 \times SY2}}$$

Time

Equations apply when *DATE1* precedes *DATE2*.

$$\text{ACTUAL DAYS} = DT_2 - DT_1$$

$$DT = 365 \times YYYY + 31 \times (MM - 1) + DD + \text{IP}\ (z/4) - x$$

where $x = 0,\ z = YYYY - 1$ for $MM \leqslant 2$

$x = \text{IP}\ (0.4 \times MM + 2.3),\ z = YYYY$ for $MM > 2$

$$\text{360 DAYS} = 360 \times (YYYY_2 - YYYY_1) + 30 \times (MM_2 - MM_1) + (\mathrm{d}_2 - \mathrm{d}_1)$$

where $d_2 = DD_2,\ d_1 = DD_1$ if $DD_1 < 30$

$d_2 = DD_2,\ d_1 = 30$ if $DD_1 \geqslant 30$ and $DD_2 < 31$

$d_2 = 30,\ d_1 = 30$ if $DD_1 \geqslant 30$ and $DD_2 = 31$

$$\text{365 DAYS} = 365 \times (YYYY_2 - YYYY_1) + (days_2 - days_1)$$

where $days_1$, $days_2$ = days this year, excluding 2/29.

Math Functions

$$C\ X,\ Y = \frac{x!}{y!(x - y)!}$$

$$P\ X,\ Y = \frac{x!}{(x - y)!}$$

$$XCOORD = R \cos \measuredangle$$

$$YCOORD = R \sin \measuredangle$$

$$R = \sqrt{XCOORD^2 + YCOORD^2}$$

$$\tan \measuredangle = \frac{YCOORD}{XCOORD} \qquad (-180^\circ < \measuredangle \leqslant 180^\circ)$$

Equations Used in Examples

Canadian Mortgages

$$PV = -PMT \times \left[\frac{1 - (1 + r)^{-N}}{r}\right] - FV \times (1 + r)^{-N}$$

where: $r = \left[\left(1 + \frac{CI\%YR}{200}\right)^{1/6} - 1\right]$

Odd-Period Calculations

$$PV \times \left[1 + i \times \frac{DAYS}{30}\right] =$$

$$-(1 + i \times S) \times PMT \times \left[\frac{1 - (1 + i)^{-N}}{i}\right] - FV \times (1 + i)^{-N}$$

where: i = periodic interest rate (as a decimal).
$S = 1$ if $DAYS < 30$.
$S = 0$ if $DAYS \geqslant 30$.

Advance Payments

$$PMT = \frac{-PV - FV \times (1 + i)^{-N}}{\left[\dfrac{1 - (1 + i)^{-(N - \#ADV)}}{i} + \#ADV\right]}$$

where: i = periodic interest rate (as a decimal).

Modified Internal Rate of Return

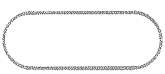
$$MIRR = 100 \times \left[\left(\frac{NFV_P}{-NPV_N}\right)^{1/n} - 1\right]$$

where: n = total number of compounding periods.
NFV_P = net future value of positive cash flows.
NPV_N = net present value of negative cash flows.

Menu Maps

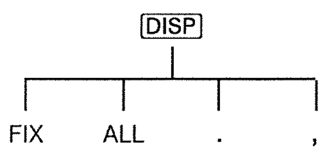
The following menu maps illustrate how to display each of the menus in the HP-19B. Menu labels for variables are enclosed in boxes to illustrate how they are used:

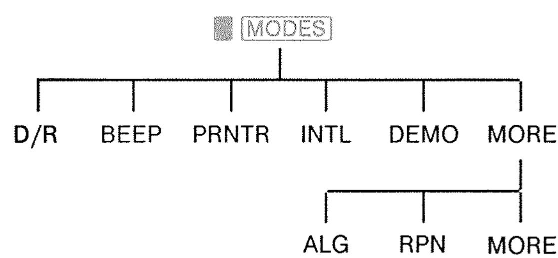
Variable used to store and/or calculate values.

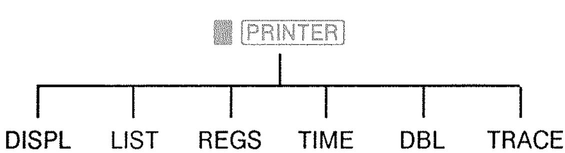


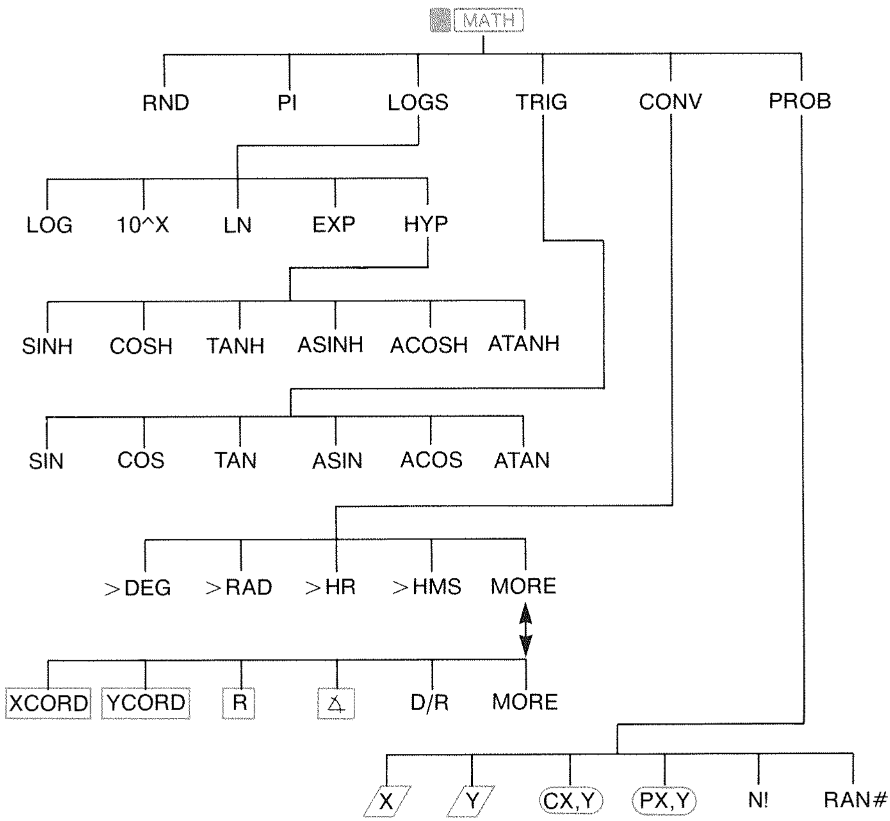
Variable used to calculate or display values; cannot be used to store values.

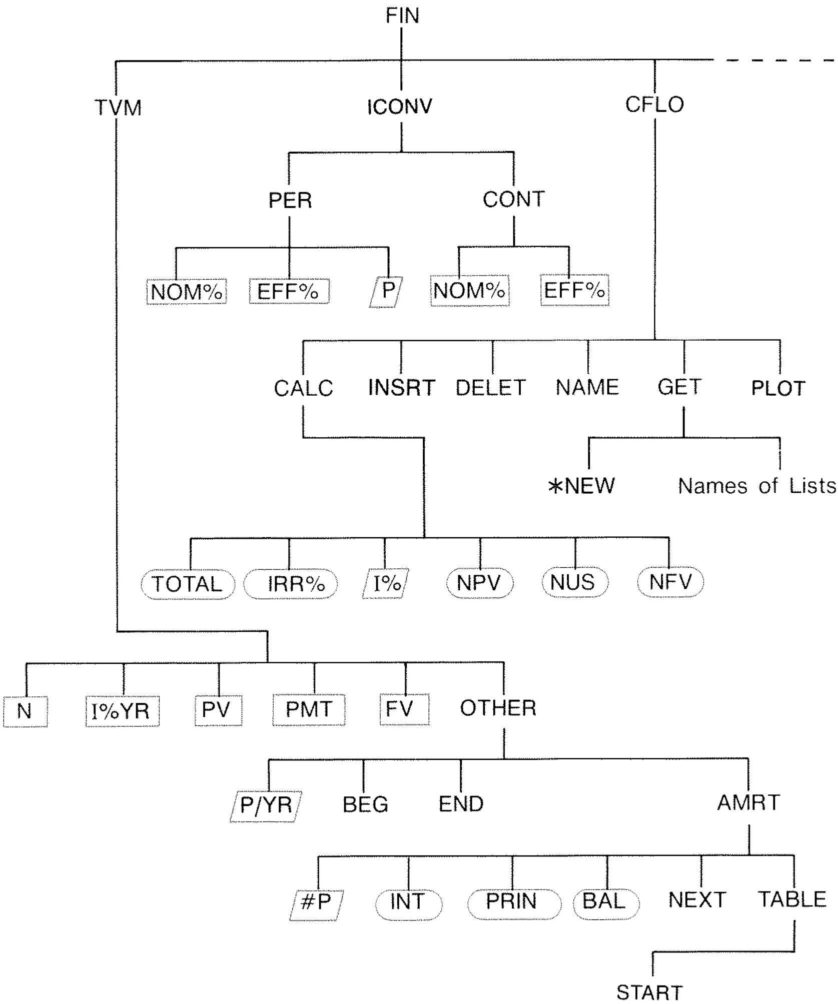
Variable used to store values; cannot be used to calculate values.

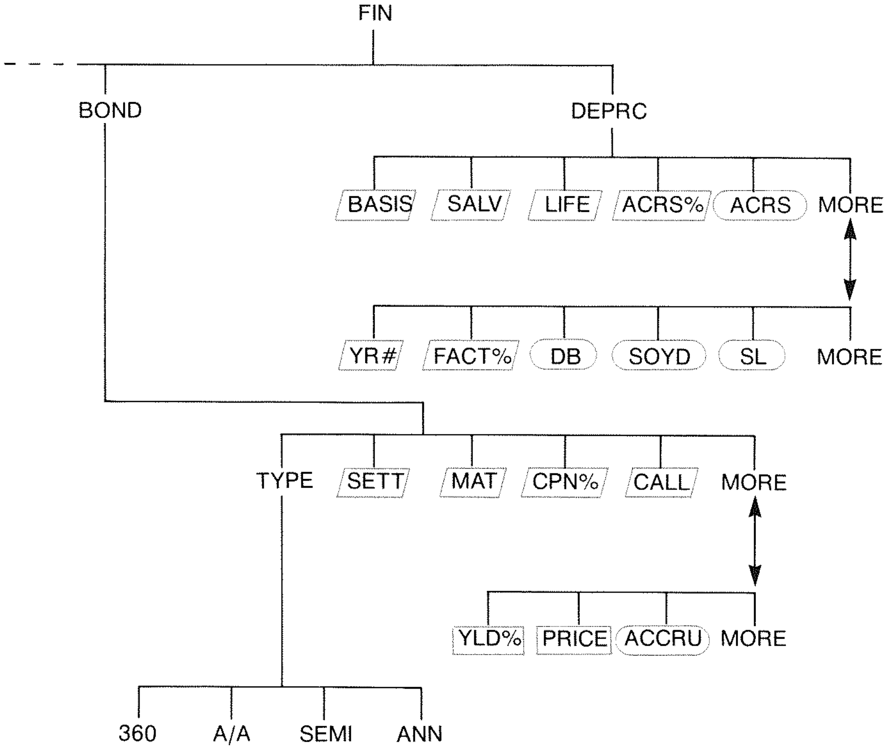


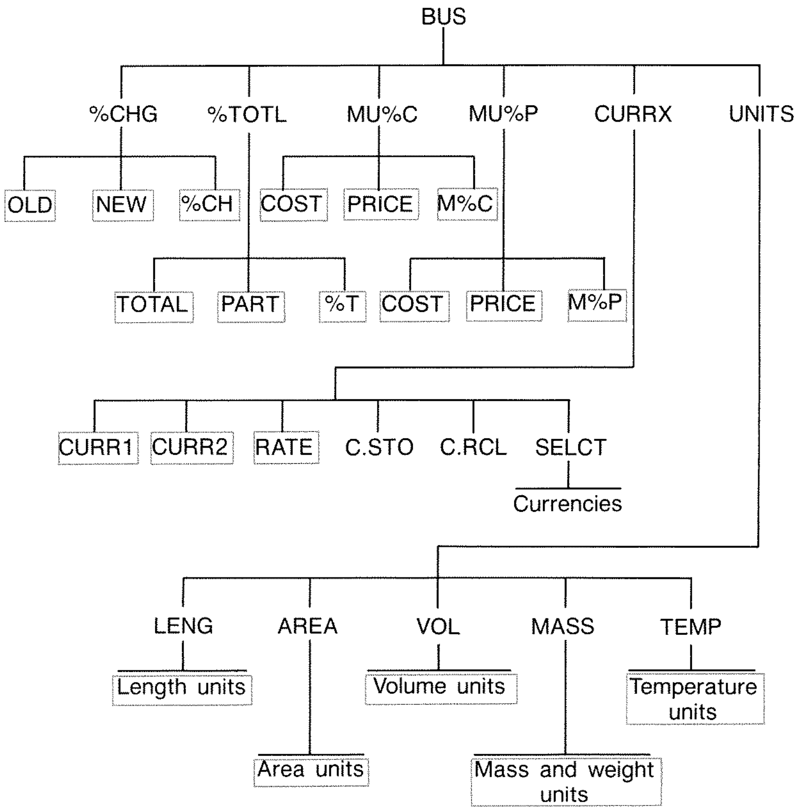


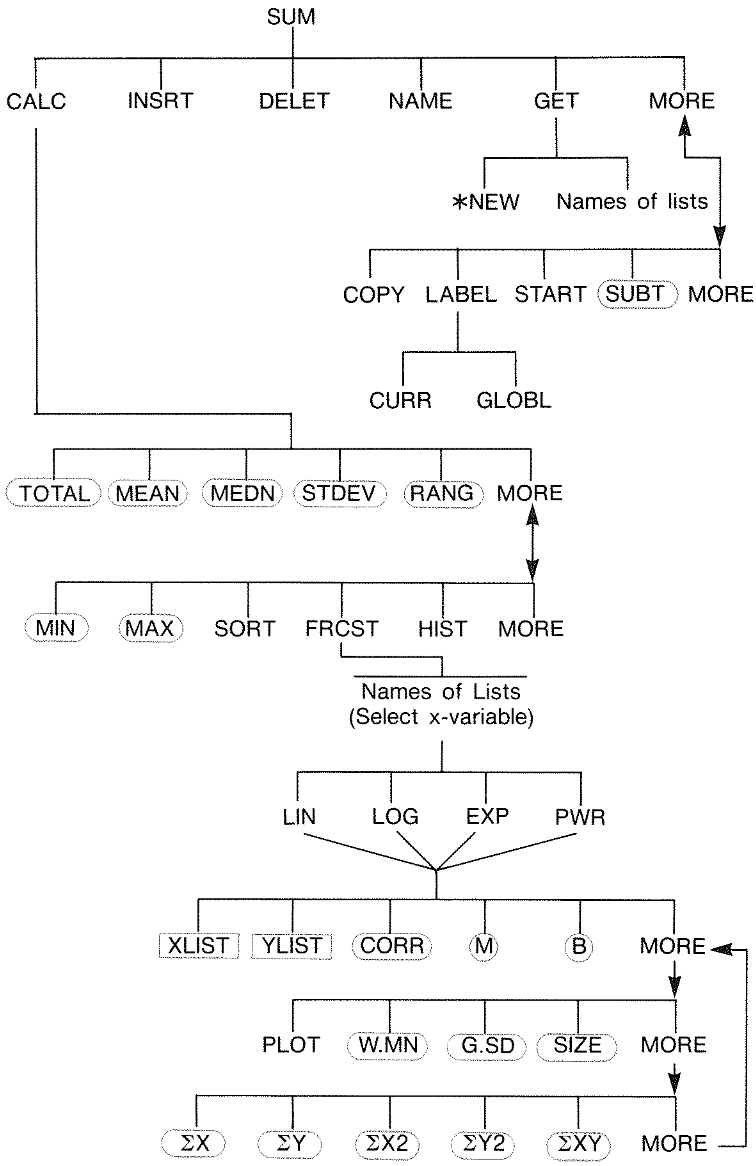


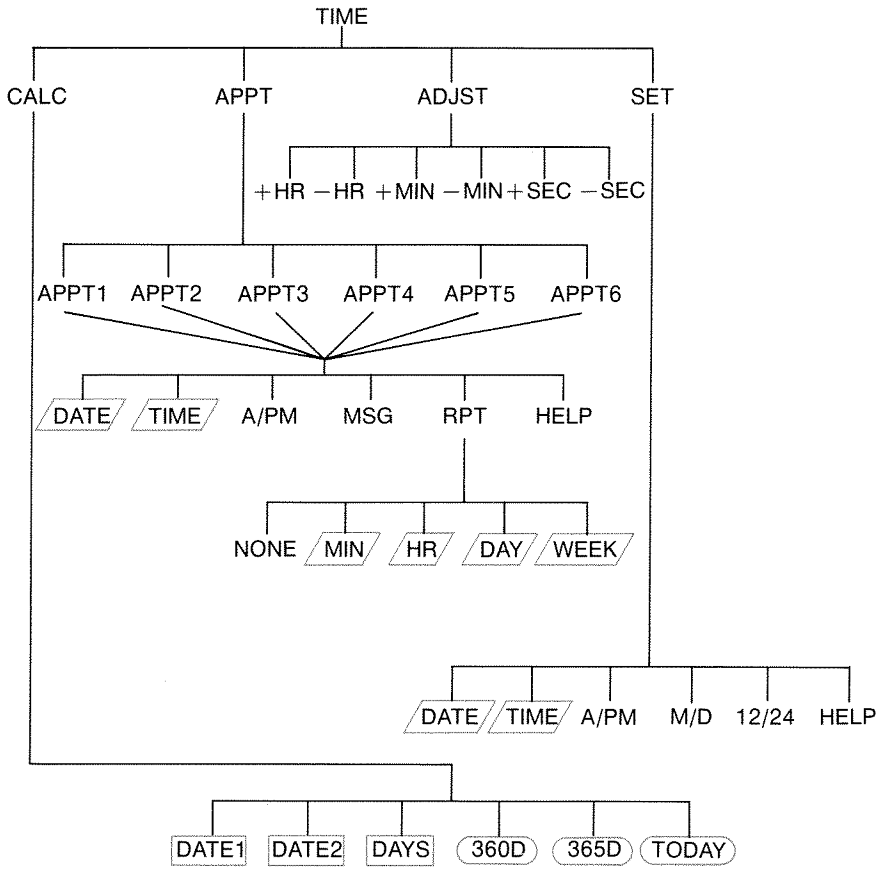

MATH
RND
PI
LOGS
TRIG
CONV
PROB
LOG
10^X
LN
EXP
HYP
SINH
COSH
TANH
ASINH
ACOSH
ATANH
SIN
COS
TAN
ASIN
ACOS
ATAN
>DEG
>RAD
>HR
>HMS
MORE
XCORD
YCORD
R
∡
D/R
MORE
X
Y
CX,Y
PX,Y
N!
RAN#

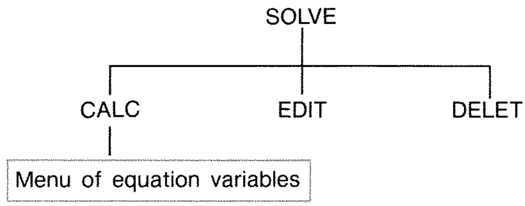

FIN
TVM
ICONV
CFLO
PER
CONT
NOM%
EFF%
P
NOM%
EFF%
CALC
INSRT
DELET
NAME
GET
PLOT
*NEW
Names of Lists
TOTAL
IRR%
I%
NPV
NUS
NFV
N
I%YR
PV
PMT
FV
OTHER
P/YR
BEG
END
AMRT
#P
INT
PRIN
BAL
NEXT
TABLE
START

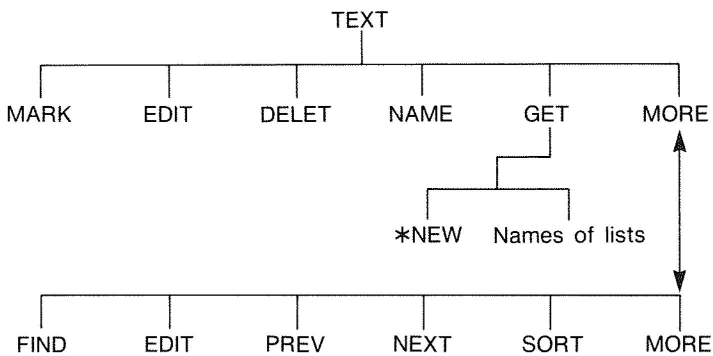

FIN
BOND
DEPRC
BASIS
SALV
LIFE
ACRS%
ACRS
MORE
YR#
FACT%
DB
SOYD
SL
MORE
TYPE
SETT
MAT
CPN%
CALL
MORE
YLD%
PRICE
ACCRU
MORE
360
A/A
SEMI
ANN


BUS
%CHG
%TOTL
MU%C
MU%P
CURRX
UNITS
OLD
NEW
%CH
COST
PRICE
M%C
TOTAL
PART
%T
COST
PRICE
M%P
CURR1
CURR2
RATE
C.STO
C.RCL
SELCT
Currencies
LENG
AREA
VOL
MASS
TEMP
Length units
Volume units
Temperature units
Area units
Mass and weight units


SUM
CALC
INSRT
DELET
NAME
GET
MORE
*NEW
Names of lists
COPY
LABEL
START
SUBT
MORE
CURR
GLOBL
TOTAL
MEAN
MEDN
STDEV
RANG
MORE
MIN
MAX
SORT
FRCST
HIST
MORE
Names of Lists
(Select x-variable)
LIN
LOG
EXP
PWR
XLIST
YLIST
CORR
M
B
MORE
PLOT
W.MN
G.SD
SIZE
MORE
ΣX
ΣY
ΣX2
ΣY2
ΣXY
MORE


TIME
CALC
APPT
ADJST
SET
+HR
−HR
+MIN
−MIN
+SEC
−SEC
APPT1
APPT2
APPT3
APPT4
APPT5
APPT6
DATE
TIME
A/PM
MSG
RPT
HELP
NONE
MIN
HR
DAY
WEEK
DATE
TIME
A/PM
M/D
12/24
HELP
DATE1
DATE2
DAYS
360D
365D
TODAY


SOLVE
CALC
EDIT
DELET
Menu of equation variables


TEXT
MARK
EDIT
DELET
NAME
GET
MORE
*NEW
Names of lists
FIND
EDIT
PREV
NEXT
SORT
MORE

D

RPN: Summary

About RPN

The RPN appendixes (D, E, and F) are especially for those of you who want to use or learn *RPN*—Hewlett-Packard's original *Reverse Polish Notation* for operating calculators. This calculator can use *either* RPN *or* algebraic logic for calculations—you choose which.

HP's RPN operating logic is based on an unambiguous, parentheses-free 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*.

Except for these appendixes, the examples and keystrokes in the manual are written entirely using Algebraic (ALG) mode.

About RPN on the HP-19B II

This appendix replaces much of chapter 2, "Arithmetic." It assumes that you already understand calculator operation as covered in chapter 1, "Getting Started." Only those features unique to RPN mode are summarized here:

- RPN mode.
- RPN functions.
- RPN arithmetic, including percentages and [STO] and [RCL] arithmetic.

All other operations — including the Solver — *work the same in RPN and ALG modes.* (The Solver uses algebraic logic only.)

For more information about how RPN works, see appendix E, "RPN: The Stack." For RPN keystrokes of selected TVM and CFLO examples, see appendix F, "RPN: Selected Examples." Continue reading in chapter 2 to learn about the other functionality of your calculator.

Watch for this symbol in the margin earlier in the manual. It identifies keystrokes that are shown in ALG mode and must be performed differently in RPN mode. Appendixes D, E, and F explain how to use your calculator in RPN mode.

The mode affects only arithmetic calculations — all other operations, including the Solver, work the same in RPN and ALG modes.

Setting RPN Mode

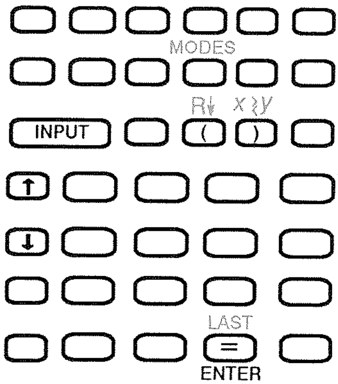
The calculator operates in either RPN (*Reverse Polish Notation*) or ALG (*Algebraic*) mode. This mode determines the operating logic used for arithmetic calculations.

To select RPN mode: Press ■ [MODES] MORE RPN .

The calculator responds by displaying RPN MODE. This mode remains until you change it. The display shows the X, Y, and Z registers from the stack.

To select ALG mode: Press ■ [MODES] MORE ALG . The calculator displays ALGEBRAIC MODE.

Where the RPN Functions Are



Function Name	Definition	Key to Use
ENTER	Enters and separates one number from the next.	[=]
LAST X	Recalls last number in X-register.	[LAST]
R↓	Rolls down stack contents.	[R↓] (*same as* [(])
R↑	Rolls up stack contents.	[↑] (except in lists)
X < > Y	X-register exchanges with Y-register.	[x≷y] (*same as* [)])
CHS	Changes sign.	[+/−]

Using INPUT for ENTER and ↓ for R↓. *Except in CFLO and SUM lists*, the [INPUT] key also performs the [ENTER] function and the [↓] key also performs the [R↓] function.

- In lists: [INPUT] stores numbers. Use [=] to enter numbers into the stack during arithmetic calculations.
- In lists: [↑] and [↓] move through lists. Use [R↓] to roll through stack contents.

Doing Calculations in RPN

Arithmetic Topics Affected by RPN Mode

This discussion of arithmetic using RPN replaces those parts of chapter 2 that are affected by RPN mode. These operations are affected by RPN mode:

- Two-number arithmetic ([+], [×], [−], [÷], [^]).
- The percent function ([%]).
- The LAST X function ([■][LAST]). See appendix E.

RPN mode does *not* affect the MATH menu, recalling and storing numbers, arithmetic done inside registers, scientific notation, numeric precision, or the range of numbers available on the calculator, all of which are covered in chapter 2.

Simple Arithmetic

Here are some examples of simple arithmetic. Notice that

- [ENTER] separates numbers that you key in.
- The operator ([+], [−], etc.) *completes* the calculation.
- One-number functions (such as [√x]) work the same in ALG and RPN modes.

Select RPN mode by pressing ■ [MODES] RPN .

To Calculate:	Press:	Display:
12 + 3	12 [ENTER] 3 [+]	15.00
12 − 3	12 [ENTER] 3 [−]	9.00
12×3	12 [ENTER] 3 [×]	36.00
$12 \div 3$	12 [ENTER] 3 [÷]	4.00
12^2	12 ■ [x^2]	144.00
$\sqrt{12}$	12 ■ [$\sqrt{x}$]	3.46
1/12	12 ■ [$1/x$]	0.08

You do not need to use [ENTER] before an operator, only *between keyed-in numbers*. Key in *both* numbers (separated by [ENTER]) before pressing the operator key.

The Power Function (Exponentiation). The power function uses the ■ [^] keys.

To Calculate:	Press:	Display:
12^3	12 [ENTER] 3 ■ [^]	1,728.00
$12^{1/3}$ (cube root)	12 [ENTER] 3 ■ [$1/x$] ■ [^]	2.29

The Percent Function. The [%] key calculates percentages *without* using the [×] key. Combined with [+] or [−], it adds or subtracts percentages.

To Calculate:	Press:	Display:
27% of 200	200 [ENTER] 27 [%]	54.00
200 less 27%	200 [ENTER] 27 [%] [−]	146.00
12% greater than 25	25 [ENTER] 12 [%] [+]	28.00

Compare these keystrokes in RPN and ALG modes:

	RPN Mode	ALG Mode
27% of 200	200 [ENTER] 27 [%]	200 [×] 27 [%] [=]
200 less 27%	200 [ENTER] 27 [%] [−]	200 [−] 27 [%] [=]

Calculations With STO and RCL

The store ([STO]) and recall ([RCL]) operations work identically in ALG and RPN modes (see "Storing and Recalling Numbers" and "Doing Arithmetic Inside Registers" in chapter 2). The keystrokes are the same for simple storing and recalling and for doing arithmetic *inside* registers and variables.

When doing arithmetic *in the display* with values from storage registers and variables, remember to use RPN. Compare these keystrokes in RPN and ALG modes:

	RPN Mode	ALG Mode
Store -2×3 in register 5	2 [+/−] [ENTER] 3 [×] [STO] 5	2 [+/−] [×] 3 [=] [STO] 5
Find *PV* − 2	FIN TVM [RCL] PV 2 [−]	FIN TVM [RCL] PV [−] 2 [=]
Find *PV* less 2%	FIN TVM [RCL] PV 2 [%] [−]	FIN TVM [RCL] PV [−] 2 [%] [=]
Find $PMT \times N$	FIN TVM [RCL] PMT [RCL] N [×]	FIN TVM [RCL] PMT [×] [RCL] N [=]

Chain Calculations — No Parentheses!

The speed and simplicity of calculating using RPN are apparent during *chain calculations* — longer calculations with more than one operation. The RPN memory stack (appendix E) stores intermediate results until you need them, then inserts them into the calculation.

The cube root example and the percentage addition example (previous topics) are two simple examples of chain calculations.

For another example, calculate

$$7 \times (12+3)$$

Start the calculation inside the parentheses by finding 12 + 3. Notice that you don't need to press [ENTER] to save this intermediate result (15) before proceeding. Since it is a calculated result, it is saved automatically — *without using parentheses*.

Keys:	Display:	Description:
12 [ENTER] 3 [+]	15.00	Intermediate result.
7 [×]	105.00	Pressing the function key produces the answer.

Now study these examples. Note the automatic storage *and retrieval* of intermediate results.

To Calculate:	Press:	Display:
$(750 \times 12) \div 360$	750 [ENTER] 12 [×] 360 [÷]	25.00
$360 \div (750 \times 12)$	360 [ENTER] 750 [ENTER] 12 [×] [÷] or 750 [ENTER] 12 [×] 360 [x≷y] [÷]	0.04
$\{(456 - 75) \div 18.5\} \times (68 \div 1.9)$	456 [ENTER] 75 [−] 18.5 [÷] 68 [ENTER] 1.9 [÷] [×]	737.07
$(3 + 4) \times (5 + 6)$	3 [ENTER] 4 [+] 5 [ENTER] 6 [+] [×]	77.00

E

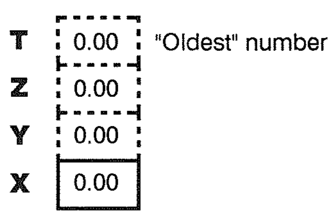
RPN: The Stack

This appendix explains how calculations take place in the automatic memory stack and how this method minimizes keystrokes in complicated calculations.

What the Stack Is

Automatic storage of intermediate results is the reason that RPN mode easily processes complicated calculations — without using parentheses. The key to automatic storage is the *automatic RPN memory stack.*

The memory stack consists of up to 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- (*top*) register.



The most "recent" number is in the X-register: *This is the bottom number you see in the display.*

Reviewing the Stack (Roll Down)

The [R↓] (*roll down*) function (on the [(] key) lets you review the entire contents of the stack by "rolling" the contents downward, one register at a time. While in RPN mode you do not need to press the shift key before [R↓].

The [↓] key has the same effect as [R↓], except in a CFLO or SUM list, when [↓] affects the list and *not* the stack. Likewise, the [↑] key rolls the contents of the stack upward, except in lists.

Rolling a Full Stack. 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:

T	1		4		3		2		1
Z	2		1		4		3		2
Y	3		2		1		4		3
X	4	[R↓]	3	[R↓]	2	[R↓]	1	[R↓]	4

When you press [R↓], the value in the X-register rotates around into the T-register. Notice that the *contents* of the registers are rolled, while the registers themselves maintain their positions. The calculator can display the X-, Y-, and Z-registers at once.

Variable Stack Size. Clearing the stack by pressing [■] [CLEAR DATA] reduces the stack to one register (X) with a zero in it. As you enter numbers, the stack builds up again. The [R↓] and [↑] functions roll through as many registers as currently exist (one, two, three, or four).

Exchanging the X- and Y-Registers in the Stack

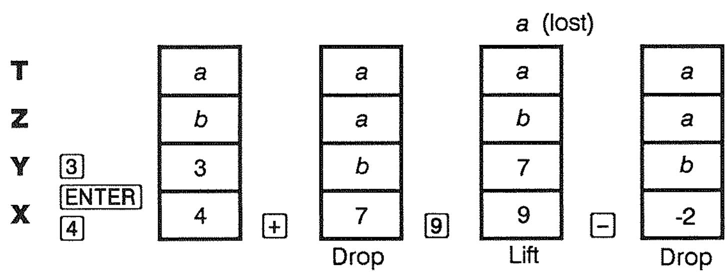
Another function that manipulates the stack contents is [*x*≷*y*] (*x exchange y*), located on the [)] key. It swaps the contents of the X- and Y-registers without affecting the rest of the stack. Pressing [*x*≷*y*] again restores the original order of the contents. While in RPN mode you do not need to press the shift key before [*x*≷*y*].

The [x⇆y] function is used primarily to swap the order of numbers in a calculation. For example, an easy way to calculate $9 \div (13 \times 8)$ is to press 13 [ENTER] 8 [×] 9 [x⇆y] [÷].

Arithmetic — How the Stack Does It

The contents of the stack move up and down automatically as new numbers enter the X-register (*lifting the stack*), and as operators combine two numbers to produce one new number in the X-register (*dropping the stack*). See how a full stack drops, lifts, and drops its contents while calculating

$$3 + 4 - 9:$$



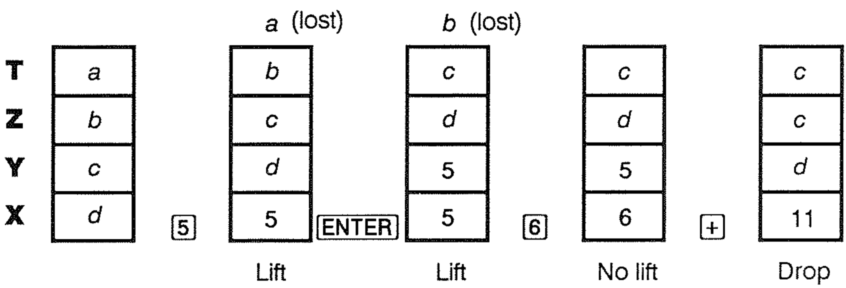
(*a* and *b* represent values already on the stack.)

- Notice that when the stack drops, it replicates the contents of the T-register and overwrites the X-register.
- When the stack lifts, it pushes the top contents out of the T-register, and that number is lost. This shows that the stack's memory is limited to four numbers for calculations.
- Because of the automatic movement of the stack, you do *not* need to clear the display before doing a new calculation.
- Most functions (besides [ENTER] and [CLEAR]) prepare the stack to lift its contents *when the next number enters the X-register.*

How ENTER Works

You know 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 filled with *a, b, c,* and *d*. Now enter and add two new numbers:

$$5 + 6:$$



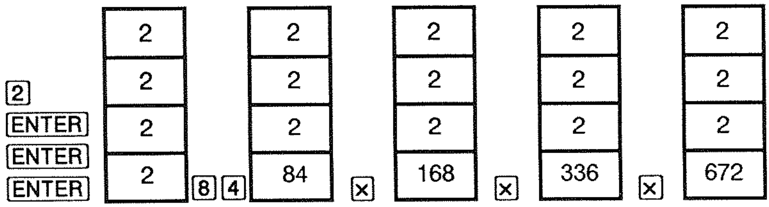
[ENTER] replicates the contents of the X-register into the Y-register. The next number you key in (or recall) *writes over* (instead of lifting) the copy of the first number left in the X-register. The effect is simply to separate two sequentially entered numbers.

Using a Number Twice in a Row. You can use the replicating feature of [ENTER] to other advantages. To add a number to itself, key in the number and press [ENTER] [+].

Filling the Stack With a Constant. The replicating effect of [ENTER], together with the replicating effect (from T into Z) of stack drop, allows you to fill the stack with a numeric constant for calculations.

Example: Constant, Cumulative Growth. The annual sales of a small hardware company are projected to double each year for the next 3 years. If the current sales are $84,000, what are the annual sales for each of the next 3 years?

1. Fill the stack with the growth rate (2 [ENTER] [ENTER] [ENTER]).
2. Key in the current sales in thousands (84).
3. Calculate future sales by pressing [×] for each of the next 3 years.



Sales for the next 3 years are projected to be $168,000; $336,000; and $672,000.

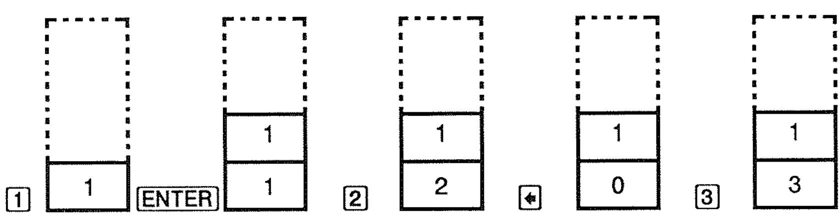
Clearing Numbers

Clearing One Number. Clearing the X-register puts a zero in it. The next number you key in (or recall) *writes over* this zero.

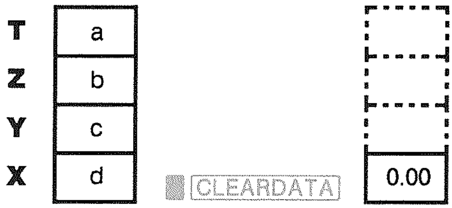
There are two ways to clear the number in the X-register:

- Press [←].
- Press [CLEAR].

For example, if you wanted to enter 1 and 3 but mistakenly entered 1 and 2, these keystrokes would correct it:



Clearing the Entire Stack. Pressing [CLEAR DATA] clears the X-register to zero and eliminates the Y-, Z-, and T-registers (reducing the size of the stack to one register). The stack expands again when you enter more numbers.



Because of the automatic movement of the stack, it is *not* necessary to clear the stack before starting a calculation. Note that if an application menu is currently displayed, pressing [CLEAR DATA] also clears the application's variables.

The LAST X Register

Retrieving Numbers From LAST X

The LAST X register is a companion to the stack: It stores the number that had been in the X-register *just before the last numeric operation* (such as a [×] operation). Pressing [LAST] returns this value to the X-register. This ability to recall the "last *x*" value has two main uses:

- Correcting errors: retrieving a number that was in the X-register just before an incorrect calculation.
- Reusing a number in a calculation.

Reusing Numbers

You can use [LAST] to reuse a number (such as a constant) in a calculation. Remember to enter the constant second, just before executing the arithmetic operation, so that the constant is the last number in the X-register, and therefore can be saved and retrieved with [LAST].

Example: Calculate $\frac{96.74 + 52.39}{52.39}$.

Keys:	Display:	Description:
96.74 [ENTER]	96.74	
52.39 [+]	149.13	Intermediate result.
■ [LAST]	52.39	Retrieves the number before the [+] operation, saved in LAST X.
[÷]	2.85	Final result.

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. This is an advantage the RPN stack has over algebraic calculator logic. Other features of RPN include the following:

- You never work with more than two numbers at a time.
- [ENTER] separates two numbers keyed in sequentially.
- Pressing an operator key executes that operation immediately.
- Intermediate results appear as they are calculated, so you can check each step as you go.
- Intermediate results are automatically stored. They reappear automatically 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—that is, from the innermost parentheses outward:

$$4 \div [14 + (7 \times 3) - 2] = 0.12$$

can be solved as 7 [ENTER] 3 [×] 14 [+] 2 [−] 4 [x⇄y] [÷]

Exercises

Here are some extra problems that you can do to practice using RPN.

Calculate: $(14 + 12) \times (18 - 12) \div (9 - 7) = 78.00$
A Solution: 14 [ENTER] 12 [+] 18 [ENTER] 12 [−] [×] 9 [ENTER] 7 [−] [÷]

Calculate: $23^2 - (13 \times 9) + {}^1/_7 = 412.14$
A Solution: 23 [■] [x^2] 13 [ENTER] 9 [×] [−] 7 [■] [$1/x$] [+]

Calculate: $\sqrt{(5.4 \times 0.8) \div (12.5 - 0.7^3)} = 0.60$
A Solution: 5.4 [ENTER] .8 [×] .7 [ENTER] 3 [■] [^] 12.5 [$x \gtrless y$] [−] [÷] [■] [$\sqrt{x}$]
or
5.4 [ENTER] .8 [×] 12.5 [ENTER] .7 [ENTER] 3 [■] [^] [−] [÷] [■] [$\sqrt{x}$]

Calculate: $\sqrt{\dfrac{8.33 \times (4 - 5.2) \div [(8.33 - 7.46) \times 0.32]}{4.3 \times (3.15 - 2.75) - (1.71 \times 2.01)}} = 4.57$

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

F

RPN: Selected Examples

The following examples selected from chapters 4 (under "Additional TVM Examples") and 5 (under "Additional CFLO Examples") have been converted to RPN keystrokes. These examples illustrate how to convert algebraic to RPN keystrokes in less common situations: with [%], with [RCL], and in a CFLO list.

Example: APR of a Loan With Fees. A borrower is charged two points for the issuance of a mortgage. (One point is equal to 1% of the mortgage amount.) If the mortgage amount is $60,000 for 30 years and the interest rate is $11^1/_2\%$ annually with monthly payments, what APR is the borrower paying?

1. Calculate *PMT*, using *PV* = $60,000 and *I%YR* = $11^1/_2\%$.
2. Adjust *PV* to reflect the amount of the loan minus the fees. Then, calculate the APR (*I%YR*), using the *PMT* calculated in step 1 (all other values remain the same).

Keys:	Display:	Description:
FIN TVM		Displays the TVM menu.
OTHER ■ [CLEAR DATA] [EXIT]	12 PMTS/YR: END MODE	If necessary, sets 12 payments/year; End mode.

Step 1: Calculate *PMT.*

Keys:	Display:	Description:
30 ▒ N	N=360.00	Stores number of monthly payments.
11.5 I%YR 60000 PV	I%YR=11.50 PV=60,000.00	Stores interest rate and amount of loan.
0 FV	FV=0.00	No balloon payment.
PMT	PMT=-594.17	Calculates monthly payment.

Step 2: Adjust *PV* and calculate *APR.*

Keys:	Display:	Description:
[RCL] PV 2 [%] [-] PV	PV=58,800.00	Stores actual amount of money received by borrower.
I%YR	I%YR=11.76	Calculates APR.

Example: Interest-Only Loan With Fees From the Lender's Point of View. A $1,000,000 10-year, 10.5% (annual interest) *interest-only* loan has an origination fee of 3 points. What is the yield to the lender? Assume that the interest-only payments are made monthly. (*PMT* is $1,000,000 × 10.5% ÷ 12, *FV* is the entire loan amount, and *PV* is the loan amount minus the points.)

Keys:	Display:	Description:
FIN TVM		Displays the TVM menu.
OTHER ▒ [CLEAR DATA] [EXIT]	12 PMTS/YR: END MODE	If necessary, sets 12 payments/year; End mode.
10 ▒ N	N=120.00	Stores total number of payments.
1000000 [ENTER] 10.5 [%] 12 [÷] PMT	PMT=8,750.00	Calculates and stores monthly payment.

1000000 FV	FV=1,000,000.00	Stores entire loan amount as balloon payment.
3 [%] [−] [+/−] PV	PV=-970,000.00	Stores amount borrowed (total − points).
I%YR	I%YR=11.00	Calculates APR, the yield to lender.

Example: Future Value and Purchasing Power of a Tax-Free Account. You open an individual retirement account with a dividend rate of 8.175%, and invest $2,000 at the beginning of each year for 35 years.

Step 1: Calculate the account balance at retirement.

Keys:	**Display:**	**Description:**
FIN TVM		Displays the TVM menu.
OTHER 1 P/YR BEG [EXIT]	1 PMTS/YR: BEGIN MODE	Sets 1 payment/year; Begin mode.
35 N	N=35.00	Stores number of payment periods until retirement.
8.175 I%YR	I%YR=8.18	Stores dividend rate.
0 PV	PV=0.00	Present value of account (before first payment) is zero.
2000 [+/−] PMT	PMT=-2,000.00	Stores annual deposit.
FV	FV=387,640.45	Calculates amount in account at retirement.

Part 2: How much have you paid into the account?

Keys:	**Display:**	**Description:**
[RCL] PMT [RCL] N [×]	-70,000.00	Calculates $PMT \times N$.

Part 3: How much interest has the account earned? (The interest earned equals the difference between *FV* and the total amount deposited.)

Keys:	**Display:**	**Description:**
[RCL] FV [+]	317,640.45	Calculates interest you will earn.

Part 4: If your post-retirement tax rate is 15%, what is the after-tax future value of the account? Assume only interest is taxed.

Keys:	**Display:**	**Description:**
15 [%]	47,646.07	Calculates taxes, 15% of total interest.
[+/-] [RCL] FV [+]	339,994.39	Subtracts taxes from total *FV* to calculate after-tax *FV*.

Part 5: Calculate the purchasing power of this amount in today's dollars, assuming an 8% annual inflation rate.

Keys:	**Display:**	**Description:**
FV 0 PMT 8 I%YR PV	PV=-22,995.36	Purchasing power is $22,995.36.

Example: Future Value and Purchasing Power of a Taxable Retirement Account.

Part 1: If you invest $3,000 each year for 35 years, with dividends taxed as ordinary income, how much will you have in the account at retirement? Assume an annual dividend rate of 8.175% and a tax rate of 28%, and that payments begin today.

Keys:	Display:	Description:
FIN TVM		Displays the TVM menu.
OTHER 1 P/YR BEG [EXIT]	1 PMTS/YR: BEGIN MODE	Sets 1 payment/year; Begin mode.
35 N	N=35.00	Stores years until retirement.
8.175 [ENTER] 28 [%] [−] I%YR	I%YR=5.89	Calculates and stores interest rate diminished by tax rate.
0 PV	PV=0.00	Stores 0 for present value.
3000 [+/−] PMT	PMT=-3,000.00	Stores annual payment.
FV	FV=345,505.61	Calculates future value of a taxed account.

Part 2: What will be the purchasing power of that amount in today's dollars, assuming 8% annual inflation?

Keys:	Display:	Description:
0 PMT 8 I%YR PV	PV=-23,368.11	Purchasing power is $23,368.11.

Example: Saving for College. Your daughter will be starting college in 12 years, at which time she will need $15,000 at the beginning of each year for four years. The fund earns 9% annually, compounded monthly, and you plan to make monthly deposits, starting at the end of the current month. How much should you deposit each month to meet her educational expenses?

For the cash-flow diagram, see figure 5-10 in chapter 5.

Remember to press the [=] *key for* [ENTER] *while working in a list.* (Pressing [INPUT] will add data to the list, not perform an ENTER.)

Keys:	Display:	Description:
FIN CFLO		Displays the CFLO menu.
■ [CLEAR DATA] YES *or* GET NEW*	▶INIT=	Clears current list or gets a new one.
0 [INPUT]	▶FLOW(1)= #TIMES=	Sets initial cash flow to zero.
0 [INPUT]	FLOW(1)=0.00 ▶#TIMES=1	Stores zero for FLOW(1).
12 [ENTER] 12 [×] 1 [−] [INPUT]	▶FLOW(2)= #TIMES=	Stores 143 (for 11 yrs., 11 mos.) in #TIMES for FLOW(1).
15000 [INPUT]	FLOW(2)=15,000.00 ▶#TIMES=1	Stores amount of first withdrawal, at end of 12th year.
[INPUT]	▶FLOW(3)= #TIMES=	First withdrawal occurs once.
0 [INPUT]	FLOW(3)=0.00 ▶#TIMES=1	Stores cash flows of zero...
11 [INPUT]	▶FLOW(4)= #TIMES=	...for the next 11 months.
15000 [INPUT] [INPUT]	▶FLOW(5)= #TIMES=	Stores second withdrawal, for sophomore year.
0 [INPUT] 11 [INPUT]	▶FLOW(6)= #TIMES=	Stores cash flows of zero for the next 11 months.
15000 [INPUT] [INPUT]	▶FLOW(7)= #TIMES=	Stores third withdrawal, for junior year.
0 [INPUT] 11 [INPUT]	▶FLOW(8)= #TIMES=	Stores cash flows of zero for the next 11 months.
15000 [INPUT] [INPUT]	▶FLOW(9)= #TIMES=	Stores fourth withdrawal, for senior year.

CALC		Displays the CALC menu.
9 [ENTER] 12 [÷] I%	I%=0.75	Stores the periodic (monthly) interest rate.
NUS	NUS=182.30	Calculates uniform payments equivalent to the series of withdrawals.

Error Messages

The messages are listed in alphabetical order. Pressing any key erases the error message and restores the previous contents of the display.

The HP-19B distinguishes between math errors that occur on the calculator line and other types of errors; messages for calculator-line math errors start with the word ERROR:.

CURRENT LIST UNNAMED;
NAME OR CLEAR THE LIST
Attempt to GET another list without first clearing or naming the current list.

EMPTY LIST
Attempt to do a calculation using an empty CFLO or SUM list.

ERROR: LOGARITHM (NEG)
Attempt to take the base 10 or natural log of a negative number.*

ERROR: LOGARITHM(0)
Attempt to take the base 10 or natural log of 0.*

ERROR: NEG^(NONINTEGER)
Attempt to raise a negative number to a non-integer power.

* These errors can occur during forecasting calculations:
- Attempt to calculate a logarithmic forecasting model with a negative or zero x-value.
- Attempt to calculate an exponential forecasting model with a negative or zero y-value.
- Attempt to calculate a power forecasting model with a negative or zero x- and/or y-value.

ERROR: OVERFLOW
An internal result in a calculation was too large for the HP-19B to handle.

ERROR: SQRT(NEG)
Attempt to take the square root of a negative number.

ERROR: UNDERFLOW
An internal result in a calculation was too small for the HP-19B to handle.

ERROR: 0^NEG
Attempt to raise 0 to a negative power.

ERROR: 0÷0
Attempt to divide 0 by 0.

ERROR: 0^0
Attempt to raise 0 to the 0 power.

ERROR: ÷0
Attempt to divide by 0.

INPUTS CAUSED ÷0
The numbers stored into built-in variables caused a division by 0 in the calculation. You must change one or more stored values.

INSUFFICIENT DATA

- Attempt to do curve fitting with only one SUM list in memory.
- Attempt to do curve fitting using an XLIST in which all the x-values are identical.
- Attempt to calculate standard deviation with only one value in the list.

INSUFFICIENT MEMORY

The calculator has insufficient memory available to do the operation you've specified (see "Managing Calculator Memory" on page 274). When there is insufficient memory to display the entire GET menu (in SUM, CFLO, or TEXT), pressing GET displays a single menu label. You must clear a portion of memory before you can display the entire GET menu. Or, you can view one label at a time; complete any incomplete calculator-line calculation, and then repeatedly exit and re-enter the GET menu.

INTEREST <= -100%

One of the following values is less than or equal to −100:

- TVM menu: *I%YR* ÷ *P/YR*.
- PER menu: *EFF%* ÷ *P* (calculating *EFF%*); *EFF%* (calculating *NOM%*).
- CONT menu: *EFF%*
- CFLO menu: *I%* or estimate of *IRR%* (when calculating *NPV*, *NUS*, or *NFV*).

INTERRUPTED

A calculation (of *I%YR*, *IRR%*, a Solver variable, or amortization) or sort was interrupted.

INVALID DATE

The number entered cannot be interpreted as a proper date. Check its format (see page 177). Acceptable dates are 10/15/1582 - 12/31/9999.

INVALID EQUATION

The Solver cannot interpret the equation.

INVALID INPUT

- Attempt to store into a built-in variable a number that is outside the range of values permitted for that variable.
- Attempt to perform a math operation with improper input.

- The number entered cannot be interpreted as a proper time.
- The alarm repeat interval is out of range.
- Attempt to enter a non-integer, negative number, or alphabetic characters when specifying the number of displayed decimal places (after pressing FIX).

INVALID N
Attempt to calculate *I%YR* with $N \leqslant 0.99999$ or $N \geqslant 10^{10}$.

INVALID NAME
Attempt to enter an incorrect list name. You cannot enter a blank name or a name consisting entirely of spaces.

IRR%>0 EXISTS; TO SEEK:
INPUT GUESS [STO]{IRR%}
Calculation of IRR produced a negative answer, but the HP-19B has determined that there is also a unique positive answer (see page 285).

MACHINE RESET
The calculator has been reset (see pages 271 and 276).

MANY OR NO SOLUTIONS
The HP-19B is unable to calculate *I%YR*. Check the values stored in *PV*, *PMT*, and *FV*. Make sure the signs of the numbers are correct. If the values of PV, PMT, and FV are correct, the calculation is too complex for the TVM menu. You may be able to perform the calculation using the CFLO menu (calculate *IRR%*).

MANY OR NO SOLUTIONS
INPUT GUESS [STO]{IRR%}

The calculation of *IRR%* is complex, and requires you to store a guess (see page 286).

MEMORY LOST
Continuous Memory has been erased (see page 276).

NAME ALREADY USED
The list name you've attempted to enter is already in use.

NO SOLUTION
No solution is possible using the current values stored in the built-in variables.

N! N<0 OR N NONINTEGER
Attempt to calculate the factorial of a negative or non-integer value.

OVERFLOW
Warning (displayed momentarily); the magnitude of a result is too large for the calculator to handle. The HP-19B returns ±9.99999999999E499 in the current display format. (See "Range of Numbers" on page 55.)

SOLUTION NOT FOUND
No solution was found by the solver using the current values stored in the variables.

TRY AGAIN, BAD GUESSES:
The initial guesses used by the Solver are inadequate to find a solution (see page 221).

UNDERFLOW
Warning (displayed momentarily); the magnitude of a result is too small for the calculator to handle. The HP-19B returns 0. (See "Range of Numbers" on page 55.)

UNEQUAL LIST LENGTHS
Attempt to do a curve-fitting calculation using lists of unequal lengths.

Index

Special Characters

A

D

F

G

H

K

L

Q

R

S

T

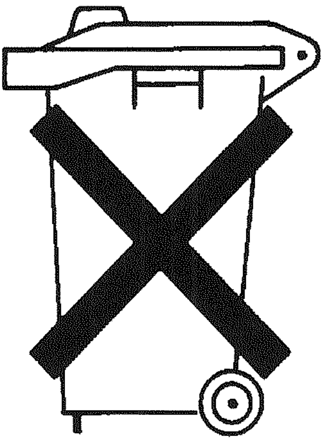
U

V

W

X, Y, Z

This regulation applies only to The Netherlands



Batteries are delivered with this product, when empty do not throw them away but collect as small chemical waste.

Bij dit produkt zijn batterijen geleverd. Wanneer deze leeg zijn, moet u ze niet weggooien maar inleveren als KCA.

Contacting Hewlett-Packard

For Information about Using the Calculator. If you have questions about how to use the calculator that are not covered in this guide, first check the table of contents, the subject index, and "Answers to Common Questions" in appendix A. If you can't find an answer in the manual, you can contact the Calculator Support Department:

Hewlett-Packard
Calculator Support
1000 N.E. Circle Blvd.
Corvallis, OR 97330, U.S.A.
(503) 715-2004 (Mon.-Fri., 8:00am-3:00pm Pacific time)
(503) 715-3628 FAX

For Hardware Service. See appendix A for diagnostic instructions and information on obtaining service. *But, before you send your unit for service, please call HP Calculator Support at the number listed below.*

Hewlett-Packard
Corvallis Service Center
1030 N.E. Circle Blvd., Bldg. 11
Corvallis, OR 97330, U.S.A.
(503) 715-2004 (HP Calculator Support)

If you are outside the United States, see appendix A for information on locating the nearest service centre.

Contents

HEWLETT PACKARD

Part Number 00019-90054 Edition 3

English
Printed in Singapore 11/94