# HEWLETT-PACKARD

HEWLET PACKARD

EXIT

25

RCL

8

6

5

STO

INPUT

CLR

0

CLEAR DATA

# **Business** Calculator

# **Owner's Manual**

# **HP-17B**





- 1. Cursor
- 2. Menu labels
- 3. Menu keys
- 4. More math
- 5. Clearing stored data
- 6. Moving through lists
- 7. Shift key (for colored functions)
- 8. On or display clear

- 9. User memory available
- 10. All decimal places
- 11. Backspace
- 12. Previous menu
- 13. Main menu
- 14. Display formats
- 15. Print speed; beeper

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By taking a moment to fill out this card, you can help HP to better understand your needs. Please read all six questions first, then fill them out. Thank you.

## **HELP US HELP YOU!**

Model Da	te acquired
Name	
Address	
City, State, Zip	
Age Phone ()	Business or Home
1. What is your POSITION OR OCCUPATION? (I         101       Student       105       Top Mana         102       Educator, Researcher       106       Owner, Pr         103       Professional Staff       107       Field Age         104       Middle Manager       108       Technician	Please check only one)         ger       109 Independent, self-employed         incipal, VP       110 Retired         nt, Rep       111 Other         n       111
<ol> <li>What is your AREA OF ACTIVITY or FIELD 0</li> <li>Mechanical Engineering</li> <li>Civil Engineering</li> <li>Electrical Engineering</li> <li>Chemical Engineering</li> <li>Other Engineering</li> <li>Surveying</li> <li>Data Processing</li> <li>Quality Control</li> </ol>	OF WORK/STUDY? (Please check only one) 209 Purchasing, Scheduling, Inventory Cntrl. 210 Accounting, Auditing 211 Finance, Investment Analysis 212 General Administration/Management 213 Marketing 214 Sales 215 Customer Service, Maintenance 216 Other
3. In what INDUSTRY do you work? (Skip if S 301	tudent or Retired. Please check only one) 310  Chemical, Refining
302 Banking, Finance, Investment	311 Agriculture, Forestry, Livestock
304 🗆 Real Estate	313 Manufacturing Industrial Goods
305 🗌 Business/Consulting Services	314 Manufacturing Consumer Goods
306 🗍 Technical Consulting	315 Transportation
307 🔲 Software, Computer Services	316 🗌 Communication, Utilities
308 Construction, Architectural	317 Dublic Admin./Government/Military
309 Mining, Oil Drilling, Exploration	318 Other
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5. How did you first hear about this model?	
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502 Advice of Friends, Colleagues, Professor	506  Salesperson
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504 Press Articles	508 🗍 Other

Manual Mfg. No. 00017-90002

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-	<ul> <li>The manual is well organized.</li> <li>I can find the information I want.</li> </ul>			3	4	5
_	The information in the manual is accurate	1	2	2	1	5
_	The information in the manual is accurate.	4	2	5	4	5
	I can easily understand the instructions.		2	3	4	5
	The manual contains enough examples.	1	2	3	4	5
	The examples are appropriate and helpful.	1	2	3	4	5
	The layout and format are attractive and useful.	1	2	3	4	5
	The illustrations are clear and helpful.	1	2	3	4	5
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# HP-17B Business Calculator

**Owner's Manual** 



Edition 1 August 1987 Reorder Number 00017-90001

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For warranty and regulatory information for this calculator, see pages 221 and 224.

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# **Printing History**

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August 1987

Mfg. No. 00017-90002

# Welcome to the HP-17B

The HP-17B is part of Hewlett-Packard's new generation of calculators:

- The *two-line display* has space for messages, prompts, and labels.
- Menus and messages show you options and guide you through problems.
- Built-in applications solve these business and financial tasks:
  - **Time Value of Money.** For loans, savings, leasing, and amortization.
  - Interest Conversions. Between nominal and effective rates.
  - **Cash Flows.** Discounted cash flows for calculating net present value and internal rate of return.
  - **Bonds.** Price or yield on any date. Annual or semi-annual coupons; 30/360 or actual/actual calendar.
  - Depreciation. Using methods of straight line, declining balance, sum-of-the-years' digits, and accelerated cost recovery system.
  - **Business Percentages.** Percent change, percent total, markup.
  - **Statistics**. Mean, correlation coefficient, linear estimates, and other statistical calculations.
  - **Clock.** Time, date, and appointments.
- The Solver for problems that aren't built in: type an equation and then solve for any unknown value. It's easier than programming!
- Use *algebraic logic* for calculations: press 2+2= and see 4.00.
- There are 6.5K bytes of memory to store data, lists, and equations.
- You can print information using the HP 82240A Infrared Printer.

# Contents

12 List of Examples	5
---------------------	---

15 How to Use This Manual

1

#### 16 Getting Started

10	detting Started
16	Power On and Off; Continuous Memory
16	Adjusting the Display Contrast
17	What You See in the Display
17	The Shift Key (📕)
18	Backspacing and Clearing
19	Doing Arithmetic
20	Keying in Negative Numbers (+/_)
20	Using the Menu Keys
21	The MAIN Menu
22	Choosing Menus and Reading Menu Maps
23	Calculations Using Menus
25	Exiting Menus (EXIT)
25	Clearing Values in Menus
26	Solving Your Own Equations (SOLVE)
27	Typing Words and Characters: the ALPHAbetic
	Menu
28	Editing ALPHAbetic Text
29	Calculating the Answer (CALC)
30	Controlling the Display Format
31	Decimal Places
31	Internal Precision
31	Temporarily SHOWing ALL
32	Exchanging Periods and Commas in Numbers
33	Error Messages
33	Beeper On and Off
34	Calculator Memory (

#### Arithmetic The Calculator Line **Doing Calculations** Using Parentheses in Calculations The Percent Key The Mathematical Operations The Power Function (Exponentiation) The MATH Menu Saving and Reusing Numbers The History Stack of Numbers Reusing the Last Result ( LAST ) Storing and Recalling Numbers Doing Arithmetic Inside Registers and Variables Scientific Notation Range of Numbers

#### 45 Percentage Calculations in Business

- Using the BUS Menus
- Examples Using the BUS Menus
- Percent Change (%CHG)
- Percent of Total (%TOTL)
- Markup as a Percent of Cost (MU%C)
- Markup as a Percent of Price (MU%P)
- 48 Sharing Variables Between Menus

#### 50 Time Value of Money

- The TVM Menu
- Cash Flow Diagrams and Signs of Numbers
- Using the TVM Menu
- Loan Calculations
- Savings Calculations
- Leasing Calculations
- Amortization (AMRT)
- Displaying an Amortization Table
- Printing an Amortization Table

#### 5

#### 73 Interest Rate Conversions

- 74 The ICNV Menu
- 74 **Converting Interest Rates**
- 77 Compounding Periods Different from Payment Periods.

6

#### **Cash Flow Calculations**

- 81 The CFLO Menu
- 82 Cash Flow Diagrams and Signs of Numbers
- 83 Creating a Cash-Flow List
- 84 **Entering Cash Flows**
- 87 Viewing and Correcting the List
- 87 Copying a Number from a List to the Calculator Line
  - 87 Naming and Renaming a Cash-Flow List
- 88 Starting or GETting Another List
- 89 Clearing a Cash-Flow List and Its Name
- 89 Cash-Flow Calculations: IRR, NPV, NUS, NFV
- 96 Doing Other Calculations with CFLO Data
- 7 97 Bonds 97

80

- The BOND Menu
- 98 Doing Bond Calculations
- 8

#### 103 Depreciation

- 103 The DEPRC Menu
- 105 Doing Depreciation Calculations
- DB, SOYD, and SL Methods 105
- 107 The ACRS Method
- 108 Partial-Year Depreciation

#### 

1	1	0	Running	Total	and	<b>Statistics</b>
---	---	---	---------	-------	-----	-------------------

- 111 The SUM Menu
- Creating a SUM List
- Entering Numbers and Viewing the TOTAL
- Viewing and Correcting the List
- Copying a Number from a List to the Calculator Line
- Naming and Renaming a SUM List
- Starting or GETting Another List
- Clearing a SUM List and Its Name
- Doing Statistical Calculations (CALC)
- Calculations with One Variable
- Calculations with Two Variables (FRCST)
- Curve Fitting and Forecasting
- Weighted Mean and Grouped Standard Deviation
- Summation Statistics
- Doing Other Calculations with SUM Data

Time, Appointments, and Date Arithmetic Viewing the Time and Date The Time Menu Setting the Time and Date (SET) Changing the Time and Date Formats (SET) Adjusting the Clock Setting (ADJST) Appointments (APPT) Viewing or Setting an Appointment (APT1-APT10)Acknowledging an Appointment Unacknowledged Appointments Clearing Appointments Date Arithmetic (CALC) Determining the Day of the Week for Any Date Calculating the Number of Days between Dates Calculating Past or Future Dates 

11	141	The Equation Solver
	141	An Example Using the Solver: Sales Forecasts
	144	The SOLVE Menu
	145	Entering Equations
	146	Calculating Using Solver Menus (CALC)
	149	Editing an Equation (EDIT)
	149	Naming an Equation
	150	Finding an Equation in the Solver List
	150	Shared Variables
	151	Clearing Variables
	151	Deleting Variables and Equations
	152	Deleting One Equation or Its Variables (DELET)
	152	Deleting All Equations or All Variables in the
		Solver (CLEAR DATA)
	153	Writing Equations
	154	What Can Appear in an Equation
	157	Solver Functions
	161	Conditional Expressions with IF
	163	The Summation Function ( $\Sigma$ )
	164	Accessing CFLO and SUM Lists from the Solver
	165	Creating Menus for Multiple Equations
		(S Function)
	166	How the Solver Works
	168	Halting and Restarting the Numerical Search
	168	Entering Guesses
		0

12	171	Printing
	172	The Printer's Power Source
	172	Printing the Display ([PRT])
	173	Printing Other Information ( PRINTER)
	174	Printing Variables, Lists, and Appointments
		(LIST)
	175	Printing Descriptive Messages (MSG)
	176	Trace Printing (TRACE)
	177	How to Interrupt the Printer
		-

#### 13 178 **Additional Examples** 178 Loans 178 Simple Annual Interest 179 Yield of a Discounted (or Premium) Mortgage 181 Annual Percentage Rate for a Loan with Fees 183 Loan with an Odd (Partial) First Period 185 Canadian Mortgages 187 Advance Payments (Leasing) 189 Savings 189 Value of a Fund with Regular Withdrawals 191 Deposits Needed for a Child's College Account Value of a Tax-Free Account 195 197 Value of a Taxable Retirement Account 198 Modified Internal Rate of Return 201 Price of an Insurance Policy 203 Bonds 205 **Discounted Notes** 206 Statistics 206 Moving Average Chi-Squared ( $\chi^2$ ) Statistics 208

A

#### 211 Assistance, Batteries, Memory, and Service

- **211** Obtaining Help in Operating the Calculator
- **211** Answers to Common Questions
- **213** Power and Batteries
- **214** Low-Power Indications
- **214** Installing Batteries
- **216** Managing Calculator Memory
- **217** Resetting the Calculator
- **218** Erasing Continuous Memory
- **218** Clock Accuracy
- **219** Environmental Limits
- **219** Determining If the Calculator Requires Service
- **220** Confirming Calculator Operation: Self-Test

Limited One-Year Warranty 221 221 What is Covered What Is Not Covered 221 Consumer Transactions in the United Kingdom 222 If the Calculator Requires Service 222 222 **Obtaining Service** 223 Service Charge 223 Shipping Instructions Warranty on Service 224 224 Service Agreements 224 **Regulatory Information** 224 Radio Frequency Interference Air Safety Notice (U.S.A.) 225

-
•
-

226

#### More About Calculations

226	IRR% Calculations
226	Possible Outcomes of Calculating IRR%
227	Halting and Restarting the IRR% Calculation
227	Storing a Guess for IRR%
228	Solver Calculations
229	Direct Solutions
230	Iterative Solutions
235	Equations Used by Built-in Menus
235	Actuarial Functions
236	Percentage Calculations in Business (BUS)
236	Time Value of Money (TVM)
236	Amortization
237	Interest Rate Conversions
237	Cash-Flow Calculations
238	Bond Calculations
239	Depreciation Calculations
239	Sum and Statistics
240	Forecasting
241	Equations Used in (Chapter 13)
241	Canadian Mortgages
242	Odd-Period Calculations
242	Advance Payments
242	Modified Internal Rate of Return

C	243	Menu Maps
	249	Error Messages
	254	Index

# List of Examples

The following list groups the examples by category.

#### **Getting Started**

- Using Menus
- Using the Solver

#### Arithmetic

- Calculating Simple Interest
- Unit Conversions
- Simple Interest at an Annual Rate

#### **General Business Calculations**

- Percent Change
- Percent of Total
- Markup as a Percent of Cost
- Markup as a Percent of Price
- Using Shared Variables
- 147 Return on Equity

#### **Time Value of Money**

- A Car Loan
- A Home Mortgage
- 59 A Mortgage with a Balloon Payment
- A Savings Account
- 62 An Individual Retirement Account
- Calculating a Lease Payment
- Present Value of a Lease with Advanced Payments and Option to Buy

- Displaying an Amortization Schedule for a Home Mortgage
- Printing an Amortization Schedule
- Calculations for a Loan with an Odd First Period
- Discounted Mortgage
- APR for a Loan with Fees
- Loan from the Lender's Point of View
- Loan with an Odd First Period
- Loan with an Odd First Period Plus Balloon
- Canadian Mortgage
- Leasing with Advance Payments
- A Fund with Regular Withdrawals
- Savings for College
- Tax-Free Account
- Taxable Retirement Account
- Insurance Policy

#### **Interest Rate Conversions**

- Converting from a Nominal to an Effective Interest Rate
- Balance of a Savings Account

#### **Cash Flow Calculations**

- Entering Cash Flows
- Calculating IRR and NPV of an Investment
- An Investment with Grouped Cash Flows
- **95** An Investment with Quarterly Returns
- Modified IRR

#### **Bonds and Notes**

- Price and Yield of a Bond
- A Bond with a Call Feature
- A Zero-Coupon Bond
- Yield to Maturity and Yield to Call
- Price and Yield of a Discounted Note

#### Depreciation

- Declining-Balance Depreciation
- ACRS Deductions
- Partial-Year Depreciation

#### **Running Total and Statistical Calculations**

- Updating a Checkbook
- Mean, Median, and Standard Deviation
- Curve Fitting
- Weighted Mean
- A Moving Average in Manufacturing
- **209** Expected Throws of a Die  $(\chi^2)$

#### **Time, Alarms, and Date Arithmetic**

- Setting the Date and Time
- Clearing and Setting an Appointment
- Calculating the Number of Days between Two Dates
- Determining a Future Date

#### How to Use the Equation Solver

- Return on Equity
- Sales Forecasts
- Using a Solver Function (USPV)
- Nested IF Functions
- Using Guesses to Find a Solution Iteratively

#### Printing

Trace-Printing an Arithmetic Calculation

# How to Use This Manual

Here are some suggestions to help you learn to use the HP-17B as quickly as possible:

- Take the time to read chapter 1. It gives you an overview of how the calculator works, and introduces terms and concepts that are used throughout the manual. After reading chapter 1, you'll be ready to start using all of the calculator's features.
- Match the problem you need to solve with the calculator's capabilities and read the related topic. You can locate information about the calculator's features using the table of contents, the subject index, the list of examples, and the menu maps in appendix C (the gold-edged pages).
- Before doing any time-value-of-money or cash-flow problems, refer to pages 53 and 82 to learn how the calculator uses positive and negative numbers in financial calculations.
- For a deeper treatment of specific types of calculations, refer to chapter 13, "Additional Examples." If you especially like learning by example, this is a good reference spot for you.

# 1

# **Getting Started**

This chapter introduces you to the HP-17B, especially its *menu*-based method of solving problems.

# **Power On and Off; Continuous Memory**

To turn on the calculator, press **CLR** (*clear*) (note ON printed below the key). To turn it off, press and then **CLR**. This *shifted* function is called **OFF** (note OFF printed above the key). Since the calculator has *Continuous Memory*, turning it off does not affect the information you've stored there.

To conserve energy, the calculator turns itself off after 10 minutes of no use.

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 on page 214.

## **Adjusting the Display Contrast**

The display's brightness depends on lighting, your viewing angle, and the display contrast setting. To change the display contrast, hold down the  $\boxed{CLR}$  key and press + or -.

# What You See in the Display

**Menu Labels.** The bottom line of the display shows the menu labels for each of the five major menus (work areas) in the calculator. More about these later in this chapter.

**The Calculator Line.** The calculator line is where you see numbers (or letters) that you enter, and the results of calculations.

**Annunciators.** The symbols shown here are called *annunciators*. Each one has a special significance.



# The Shift Key (

Some keys have a second, *shifted* function printed in color above the key. The colored shift key accesses these operations. For example, pressing and releasing , then pressing CLR turns the calculator off. This is written **CFF**.

Pressing  $\blacksquare$  turns on the shift annunciator ( $\_\_$ ). This symbol stays on until you press the next key. If you ever press  $\blacksquare$  by mistake, just press  $\blacksquare$  again to turn off the  $\_\_$ .

# **Backspacing and Clearing**

The following keys erase typing mistakes, entire numbers, or even lists or sets of data.

Key	Description
•	Backspace; erases the character before the cursor.
CLR	Clear; clears the calculator line. (When the calculator is off, this key turns the calculator on, but <i>without</i> clearing anything.)
CLEAR DATA	This clears all information in the current work area ( <i>menu</i> ). For example, it will erase all the numbers in a list if you are currently viewing a list (SUM or CFLO). In other menus (like TVM), CLEAR DATA clears all of the values that have been stored. In SOLVE, it can delete all equations.

Table 1-1. Keys for Clearing

The cursor ( $\blacksquare$ ) is visible while you are keying in a number or doing a calculation. When the cursor is visible, pressing  $\blacklozenge$  deletes the last character you keyed in. When the cursor is not visible, pressing  $\blacklozenge$  erases the last number.

Keys:	Display:	Description:
12345 <b>(</b>	123.66	Backspacing removes the 4 and 5.
+ 18 1/x	123.66+0.06	Calculates 1/18.
	123.66+	Erases the last result.
CLR	0.00	Clears the calculator line.

In addition, there are more drastic clearing operations that erase more information at once. Refer to "Resetting the Calculator" on page 217 in appendix A.

# **Doing Arithmetic**

To colorilate  $21.1 \pm 22.9$ 

This is a brief introduction to doing arithmetic. More information on arithmetic is in chapter 2. Remember that you can erase errors by pressing (•) or CLR.

10 calculate $21.1 + 25.0$ .				
Keys:	Display:	Description:		
21.1 +	21.10+			
23.8	21.10+23.8			
=	44.90	= completes calculation.		

Once a calculation has been completed, pressing another digit key *starts* a new calculation. On the other hand, pressing an operator key *continues* the calculation:

77.35 –	77.35-	Calculates 77.35 — 90.89.
90.89 =	-13.54	
65 <b>[</b> [ × 12 =	96.75	New calculation: $\sqrt{65} \times 12$ .
÷ 3.5 =	27.64	Calculates 96.75 $\div$ 3.5.

You can also do long calculations *without* pressing  $\equiv$  after each intermediate calculation—just press it at the end. The operators perform from left to right, in the order you enter them. Compare:

	$\frac{65 + 12}{3.5}$	and	$65 + \frac{12}{3.5}$
65 + 12 ÷ 3.5 =	22.00		Operations occur in the order you see them.
65 + () 12 ÷ 3.5 )) =	68.43		Use parentheses to im- pose an order of calculation.

# Keying in Negative Numbers (+/\_)

The +/\_ key changes the sign of a number.

- To change the sign of an already displayed number (it must be the rightmost number), press +/\_.

Keys:	Display:	Description:
75 +/_	-75	Changes the sign of 75.
× 7.1 =	-532.50	Multiplies $-75$ by 7.1.

# **Using the Menu Keys**

The calculator usually displays a set of labels across the bottom of the display. The set is called a *menu* because it presents you with choices. The MAIN menu is the starting point for all other menus.



The top row of keys is related to the labels along the bottom of the display. The labels tell you what the keys do. The six keys are called *menu keys*; the labels are called *menu labels*.

# The MAIN Menu

The MAIN menu is a set of primary choices leading to other menu options. No matter which menu you currently see, pressing MAIN redisplays the MAIN menu. The menu structure is *hierarchical*.

Menu Label	Operations Done in This Category	Covered in:
FIN (Finance)	TVM: Time value of money: loans, savings, leasing, amortization.	Chapter 4
	ICNV: Interest conversions.	Chapter 5
	CFLO: Lists of cash flows for in- ternal rate of return and net present value.	Chapter 6
	BOND: Yields and prices for bonds.	Chapter 7
	DEPRC: Depreciation using SL, DB, and SOYD methods, or ACRS.	Chapter 8
BUS (Business Percentages)	Percent of total, percent change, markup on cost, markup on price.	Chapter 3
SUM (Statistics)	Lists of numbers, running total, mean, weighted statistics, fore- casting, summation statistics, and more.	Chapter 9
TIME (Time Manager)	Clock, calendar, appointments, date arithmetic.	Chapter 10
SOLVE (Equation Solver)	Creates customized menus from your own equations for calcula- tions you do often.	Chapter 11

#### Table 1-2. The MAIN Menu

## **Choosing Menus and Reading Menu Maps**

Below is a *menu map* illustrating one possible path through three levels of menus: from the MAIN menu to the BUS menu to the MU%C (*markup as a 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.



- Press BUS to choose the BUS menu. Then press MU%C to choose the MU%C menu.
- Press EXIT to return to the previous menu. Pressing EXIT enough times returns you to the MAIN menu.
- Press MAIN to return to the MAIN menu directly.

When a menu has more than six labels, the label **MORE** appears at the far right. Use it to switch between sets of menu labels on the same "level".

**Example: Using Menus.** Refer to the menu map for MU%C (above) along with 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 lets you 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.** Key in the cost and press **COST** to store 4.10 as the COST.

COST=4.10 COST PRICE MKC

- **Step 6.** Key in the price and press **PRICE** to store 4.60 as the *PRICE*.
- **Step 7.** Press M<sup>\*</sup>C to calculate the markup as a percent of cost. The answer: MARKUP<sup>\*</sup>C=12.20.

MARKUP%C=12.20	
COST PRICE MXC	

**Step 8.** To leave the MU%C menu, press **EXIT** twice (once to get back to the BUS menu, and again to get to the MAIN menu) or **MAIN** (to go directly to the MAIN menu).

#### **Calculations Using Menus**

Using menus to do calculations is easy. You don't have to remember in what order to enter numbers and in what order results come back. Instead, the menus guide you, as in the previous example. All the keys you need are together in the top row. The menu keys both store numbers for the calculations and start the calculations. The MU%C menu can calculate M%C, the percent markup on cost, given *COST* and *PRICE*.



Then the same menu can calculate PRICE given COST and M%C.



Notice that the two calculations use the same three variables; each variable can be used both to store and calculate values. These are called *built-in variables*, because they are permanently built into the calculator.

Many menus in this calculator work like the example above. The rules for using variables are:

- To store a value, key in the number and press the menu key.\*<sup>†</sup> (Arithmetic calculations are automatically completed. For example, 2 × 50 COST stores 100 in *COST*.)
- To calculate a value, press the menu key without first keying in a number. The calculator displays CALCULATING... when a value is being calculated.
- To verify a stored value, press RCL (*recall*) followed by the menu key. For example, RCL COST displays the value stored in COST.
- **To transfer a value to another menu**, do nothing if it is displayed (that is, it is in the calculator line). A number in the calculator line remains there when you switch menus. To transfer more than one value from a menu, use storage registers. See page 42, "Storing and Recalling Numbers."

#### Exiting Menus (EXIT)

The **EXIT** key is used to leave the current menu and go back to the previously displayed menu (as shown in the previous example). This is true for menus you might pick by accident, too: **EXIT** gets you out.

#### **Clearing Values in Menus**

The CLEAR DATA key is a powerful feature to clear all the data in the currently displayed menu, giving you a clean slate for new calculations.

<sup>\*</sup> If you have just switched menus and want to store the result already in the calculator line, then you should press <u>STO</u> or = before the menu key.

<sup>&</sup>lt;sup>†</sup> To store the same number into two different variables, use STO or = for the second variable, e.g. 25 PRICE STO COST.

- If the current menu has variables (that is, if the display shows menu labels for variables, such as COST, PRICE, and M%C in the MU%C menu), pressing CLEAR DATA clears the values of those variables to zero.
- If the current menu has a list (SUM, CFLO, or Solver), pressing
   CLEAR DATA clears the values in the list.

To see what value is currently stored in a variable, press **RCL** *menu label*.

# **Solving Your Own Equations (SOLVE)**

This chapter has introduced some of the built-in menus the calculator offers. But if the solution to a problem is not built into HP-17B, you can turn to the most versatile feature of all: the *Equation Solver*. Here you define your own solution in terms of an equation. The Solver then creates a menu to go with your equation, which you can use over and over again, just like the other menus in the calculator.

The Solver is covered in chapter 11, but here is an introductory example. Because equations usually use letters of the alphabet, this section also explains how to type and edit letters and other characters that aren't on the keyboard.

**Example: Using the Solver.** 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 do the calculation (even if you do it longhand), you are using an equation.



To type this equation into the Solver, use the ALPHA menu.

## Typing Words and Characters: the ALPHAbetic Menu

The ALPHAbetic menu is automatically displayed when you need it to type letters and characters. The ALPHA menu also includes characters not found on the keyboard:

- Uppercase letters.
- Space.
- Punctuation and special characters.
- Non-English letters.



To type a letter you need to press two keys; for example, A is produced by the keystrokes ABCDE A.

Each letter menu has an **OTHER** key for accessing punctuation and non-English characters. The letter menus with just four letters (for example, FGHI) include a space character (

To familiarize yourself with the ALPHA menu, type in the equation for the cost of carpeting. The necessary keystrokes are shown below. (Note the access to the special character, "/".) Use (•), if necessary, to make corrections. If you need to do further editing, refer to the next section, "Editing ALPHAbetic Text." When you're satisfied that the equation is correct, press INPUT to enter the equation into memory.



Note that the  $\times$  is just a character, part of the variable's name. It is *not* an operator, which  $\div$  is.

## **Editing ALPHAbetic Text**

The companion to the ALPHA menu is the ALPHA-Edit menu. To display the ALPHA-Edit menu, press **EDIT** in the SOLVE menu (or press **EXIT** in the ALPHA menu).



Operation	Label or Key to Press
ALPHA-Edit Menu	
Inserts character before the cursor.	Any character.
Deletes character at the cursor.	DEL
Moves the cursor far left, one display-width.	<<
Moves the cursor left.	<
Moves the cursor right.	>
Moves the cursor far right, one display-width.	>>
Displays the ALPHA menu again.	ALPHA
Keyboard	
Backspaces and erases the character before the cursor.	۲
Clears the calculator line.	CLR

#### Table 1-3. Alphabetic Editing

#### **Calculating the Answer (CALC)**

After an equation is input, pressing **CALC** verifies it and creates a new, customized menu to go with the equation.

0.00				
P/YD	L	М	CBST	
		~		

Menu labels for your variables

Each of the variables you typed into the equation now appears as a menu label. You can store and calculate values in this menu the same way you do in other menus.

Calculate the cost of carpet needed to cover a 9' by 12' room. The carpet costs \$22.50 per square yard.

Starting from the MAIN menu (press MAIN):

Keys:	Display:	Description:
SOLVE	P∕YD×L×W÷9=COST	Displays the SOLVE menu and the current equation.*
CALC		Displays the customized menu for carpeting.
22.5 P/YD	P∕YD=22.50	Stores the price per square yard in $P/YD$ .
12 L	L=12.00	Stores the length in L.
9 W	W=9.00	Stores the width in W.
COST	COST=270.00	Calculates the cost to cover a 9' $\times$ 12' room.

Now determine the most expensive carpet you can buy if the maximum amount you can pay is \$300. Notice that all you need to do is enter the one value you are changing—there is no need to re-enter the other values.

COST=300.00	Stores \$300 in COST.
P∕YD=25.00	Calculates the maximum price per square yard you can pay.
	Exits Solver.
	COST=300.00 P∕YD=25.00

# **Controlling the Display Format**

The DSP menu (press DSP) gives you options for formatting numbers. You can pick the number of decimal places to be displayed, and whether to use a comma or a period to "punctuate" your numbers.

\* If you entered this equation but don't see it now, press  $\blacktriangle$  or  $\blacktriangledown$  until you do.
# SELECT DISPLAY FORMAT

#### **Decimal Places**

To change the number of displayed decimal places, first press the DSP key. Then either:

- Press FIX , type the number of decimal places you want (from 0 to 11), and press INPUT; or
- Press ALL to see a number as precisely as possible at any time (12 digits maximum).

#### **Internal Precision**

Changing the number of displayed decimal places affects what you see, but does not affect the internal representation of numbers. The number inside the calculator always has 12 digits.



#### **Temporarily SHOWing ALL**

To *temporarily* see a number with full precision, press **SHOW**. This shows you the ALL format for as long as you hold down **SHOW**.

Starting with two displayed decimal places:

Keys:	Display:	Description:
45 🗙 .1256 =	5.65	Two decimal places.
DSP FIX 4 INPUT	5.6520	Four decimal places are displayed.
DSP ALL	5.652	All significant digits; trailing zeros dropped.
DSP FIX 2 INPUT	5.65	Two decimal places are displayed.
(hold)	FULL PRECISION IS: 5.652	Temporarily shows full precision.

#### **Exchanging Periods and Commas in Numbers**

To exchange the periods and commas used for the decimal point and digit separators in a number:

- **1.** Press DSP to access the DSP (*display*) menu.
- **2.** Specify the decimal point by pressing \_\_\_\_\_\_ or \_\_\_\_\_. Pressing \_\_\_\_\_\_ or \_\_\_\_\_. Pressing \_\_\_\_\_\_\_ sets a period as the decimal point and comma as the digit separator (U.S. mode). (For example, 1,000,000.00.) Pressing \_\_\_\_\_\_\_ sets a comma as the decimal point and period as the digit separator (non-U.S. mode). (For example, 1.000.000,00.)

# **Error Messages**

Sometimes the calculator cannot do what you "ask", such as when you press the wrong key or forget a number for a calculation. To help you correct the situation, the calculator beeps and displays a message.

- Press CLR or to clear the error message.
- Press any other key to clear the message and perform that key's function.

For more explanations, refer to the list of error messages just before the subject index.

#### **Beeper On and Off**

Beeping occurs when a wrong key is pressed, when an error occurs, and during alarms for appointments. You can suppress and re-activate the beeper in the MODES menu as follows:

- 1. Press MODES.
- **2.** Pressing **BEEP** will simultaneously change and display the current setting for the beeper:
  - BEEPER ON beeps for errors and appointments.
  - BEEPER ON: APPTS ONLY beeps only for appointments.
  - BEEPER OFF silences the beeper completely.
- **3.** Press **EXIT** when done.

# Calculator Memory (

The calculator stores many different types of information in its memory. Each piece of information requires a certain amount of storage space.\* You can monitor the amount of *available memory* by pressing **MEM**.



The amount of memory available for storing information and working problems is about 6,750 bytes.<sup>†</sup> (Units of memory space are called *bytes*.) The calculator gives you complete flexibility in how you use that available memory (such as for lists of numbers or equations). Use as much of the memory as you want for any task you want.

If you use nearly all of the calculator's memory, you'll encounter the message INSUFFICIENT MEMORY. To remedy this situation, you must erase some previously stored information. Refer to "Managing Calculator Memory" on page 216 in appendix A.

The calculator also allows you to erase at once *all* the information stored inside it. This procedure is covered in "Erasing Continuous Memory" on page 218.

<sup>\*</sup> Storing numbers in menus like TVM (non-Solver menus) does *not* use any of your memory space.

<sup>&</sup>lt;sup>†</sup>There are 8,000 bytes total in RAM (random access memory): 6,750 bytes plus 1,250 bytes reserved by the system to store your values in built-in variables.

# 2

# Arithmetic

# **The Calculator Line**

The calculator line is the part of the display where numbers appear and calculations take place. Sometimes this line includes labels for results, such as TOTAL=124.60. Even in this case you can use the number for a calculation. For example, pressing  $+ 2 \equiv$  would calculate 124.60 plus 2, and the calculator would display the answer, 126.60.

There is always a number in the calculator line, even though sometimes the calculator line is hidden by a message (such as SELECT COMPOUNDING). To see the number in the calculator line, press , which removes the message.

# **Doing Calculations**

Simple calculating was introduced in chapter 1, page 19. Often longer calculations involve more than one operation. These are called *chain calculations* because several operations are "chained" together. To do a chain calculation, you don't need to press = after each operation, but only at the very end.

For instance, to calculate  $\frac{750 \times 12}{360}$  you can type either: 750  $\times$  12 =  $\div$  360 = *or* 750  $\times$  12  $\div$  360 = In the second case, the  $\div$  key acts like the = key by displaying the result of 750  $\times$  12.

Here's a longer chain calculation.

$$\frac{456-75}{18.5} \times \frac{68}{1.9}$$

This calculation can be written as:  $456 - 75 \div 18.5 \times 68 \div 1.9$ .

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

Keys:	Display:
456 – 75 ÷	381.00÷
18.5 ×	20.59×
68 ÷	1,400.43÷
1.9 =	737.07

#### **Using Parentheses in Calculations**

Use parentheses when you want 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  $30 \div 85$  –, the calculator would calculate the intermediate result, 0.35. However, that's not what you want. To delay the division until you've subtracted 12 from 85, 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	Calculates $0.41 \times 9$ .

Note that you must include a  $\times$  for multiplication; parentheses do *not* imply multiplication.

# **The Percent Key**

The % key has two functions:

**Finding a Percentage.** In most cases, % divides a number by 100. The one exception is when a plus or minus sign precedes the number. (See "Adding or Subtracting a Percentage," below.)

For instance, 25 % results in 0.25.

To find 25% of 200, press: 200 × 25 % =. (Result is 50.00.)

**Adding or Subtracting a Percentage.** You can do this all in one calculation:

For instance, to decrease 200 by 25%, just enter 200 - 25 % =. (Result is 150.00.)

**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 %	1,250.00+87.50	Interest on the loan is \$87.50.
=	1,337.50	You must repay this amount at the end of one vear.

# **The Mathematical Functions**

Some of the math functions appear on the keyboard; others are in the MATH menu. Math functions act on the last number in the display.

#### **Table 2-1. Shifted Math Functions**

Key	Description
1/x	reciprocal
<b>√</b> x	square root
<b>x</b> <sup>2</sup>	square

Keys:	Display:	Description:
4 <b>1/x</b>	0.25	Reciprocal of 4.
20 📕 🖅	4.47	Calculates $\sqrt{20}$ .
+ 47.2 ×	51.67×	Calculates 4.47 + 47.20.
1.1 <b>x</b> <sup>2</sup>	51.67×1.21	Calculates 1.1 <sup>2</sup> .
=	62.52	Completes calculation of $(4.47 + 47.2) \times 1.1^2$ .

#### **The Power Function (Exponentiation)**

The power function,  $\mathbf{y}^{\mathbf{x}}$ , raises the preceding number to the power of the following number.

Keys:	Display:	Description:
125 <mark>- y</mark> x 3 =	1,953,125.00	Calculates 125 <sup>3</sup> .
125 y <sup>x</sup> 3	5.00	Calculates the cube root of 125, which is the same as $(125)^{\frac{1}{3}}$ .

# The MATH Menu

To display the MATH menu, press **MATH** (the shifted % key). Like the other mathematics functions, these functions operate on only the last number in the display.

Menu Label	Description
LOG	Common (base 10) logarithm of a positive number.
10^X	Common (base 10) antilogarithm; calculates 10 <sup>x</sup> .
LN	Natural (base e) logarithm of a positive number.
EXP	Natural antilogarithm; calculates e <sup>x</sup> .
N!	Factorial.
PI	Inserts the value for $\pi$ into the display.

Keys:	Display:	Description:
2.5 MATH 10^X	316.23	Calculates 10 <sup>2.5</sup> .
790 + 4 N!	790.00+24.00	Calculates the factorial of 4.
=	814.00	Completes calculation.
EXIT		Exits MATH menu.

You can access the MATH menu when another menu is displayed. For instance, while using SUM you might want to use a MATH function. Just press MATH, then perform the calculation. Pressing EXIT returns you to SUM. The MATH result remains in the calculator line. Remember, however, that you must exit MATH before you resume using SUM.

# **Saving and Reusing Numbers**

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

## **The History Stack of Numbers**

When you start a new operation, the previous result moves out of the display *but is still accessible*. Up to four lines of numbers are saved: one in the display and three hidden. These lines make up the *history stack*.



The  $\bigtriangledown$  and  $\blacktriangle$  keys "roll" the history stack down or up one line, bringing the hidden results back into the display. If you hold down  $\blacklozenge$  or  $\bigtriangledown$ , the history stack wraps around on itself. However, you cannot roll the history stack when an incomplete calculation is in the display. Also, you cannot gain access to the stack while using lists (SUM, CFLO, SOLVE).

All numbers in the history stack are retained when you switch menus.

Pressing CLEAR DATA clears the history stack. Be careful if a menu is active, because then CLEAR DATA also erases the data associated with that menu.

Keys:	Display:	Description:
75.55 — 32.63 =	42.92	
150 ÷ 7 =	21.43	42.92 moves out of display.

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

42.92 Moves 42.92 back to calculator line.
 11 = 472.12

#### **Reusing the Last Result** (**ELAST**)

The **LAST** key copies the last result—that is, the number just above the calculator line in the history stack—into a current calculation. This lets you reuse a number without retyping it and also lets you break up a complicated calculation.

$$\frac{39 + 8}{\sqrt{123 + 17}}$$

Keys:	Display:	Description:
123 + 17 =	140.00	Calculates 123 + 17.
<u>Jx</u>	11.83	Calculates $\sqrt{140}$ .
39 + 8 = ÷	47.00÷11.83	Copies 11.83 to the calcu- lator line.
=	3.97	Completes the calculation.

An equivalent keystroke sequence for this problem would be: 39 + 8  $\div$  () 123 + 17 ))  $\blacksquare$   $f_x$   $\equiv$ 

## **Storing and Recalling Numbers**

The <u>STO</u> key copies a number from the calculator line into a designated storage area, called a *storage register*. There are ten storage registers in calculator memory, numbered 0 through 9. The <u>RCL</u> key recalls stored numbers back to the calculator line.

If there is more than one number on the calculator line, **STO** stores only the last number in the display.

To store or recall a number:

- **1.** Press STO or RCL. (To cancel this step, press ().)
- 2. Key in the register number.

The following example uses two storage registers to do two calculations that use some of the same numbers.

	475.6 39.15	$\frac{560.1 + 475.6}{39.15}$
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 (rightmost number) into register 2.
=	12.15	Completes calculation.
560.1 + RCL 1	560.10+475.60	Recalls contents of regis- ter 1.
÷ RCL 2	1,035.70÷39.15	Recalls register 2.
=	26.45	Completes calculation.

The STO and RCL keys can also be used with variables. For example, STO MC (in the MU%C menu) stores the rightmost number from the display into the variable M%C. [RCL] M%C copies the contents of M%C into the calculator line. If there is an expression in the display (such as 2+41), then the recalled number replaces only the last number.

You do not need to clear storage registers before using them. By storing a number into a register, you overwrite whatever existed there before.

### **Doing Arithmetic Inside Registers and Variables**

You can also do arithmetic inside storage registers.

Keys:	Display:	Description:
45.7 STO 3	45.70	Stores 45.7 in reg. 3.
2.5 (STO)× 3	2.50	Multiplies contents of register 3 by 2.5 and stores result (114.25) back in register 3.
RCL 3	114.25	Displays register 3.

114.25

#### **Table 2-3. Arithmetic in Registers**

Keys	New Register Contents
STO +	old register contents + displayed number
STO -	old register contents - displayed number
STOX	old register contents $\times$ displayed number
[STO]÷]	old register contents $\div$ displayed number
STO yx	old register contents ^ displayed number

You can also do arithmetic with the values stored in variables. For example, 2 STO X M2C (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 working with very large or very small numbers. Scientific notation shows a small number (less than 10) times 10 raised to a power. For example, the 1984 Gross National Product of the United States was \$3,662,800,000,000. In scientific notation, this is  $3.6628 \times 10^{12}$ . For very small numbers the decimal point is moved to the right and 10 is raised to a negative power. For example, 0.00000752 can be written as  $7.52 \times 10^{-6}$ .

When a calculation produces a result with more than 12 digits, the number is automatically displayed in scientific notation, using a capital E in place of " $\times$  10^".

Remember that +/ changes the sign of the entire number, and not of the exponent. Use - to make a negative exponent.

Type in the numbers  $4.78 \times 10^{13}$  and  $-2.36 \times 10^{-15}$ .

Keys:	Display:	Description:
4.78 📕 E 13	4.78E13	Pressing <b>E</b> starts the exponent.
CLEAR DATA	0.00	Clears number.
2.36 E – 15	2.36E-15	Pressing — before an ex- ponent makes it negative.
+/	-2.36E-15	Pressing <u>+/</u> makes the entire number negative.
CLEAR DATA		Clears number.

# **Range of Numbers**

The largest positive and negative numbers available on the calculator are  $\pm 9.99999999999 \times 10^{499}$ ; the smallest positive and negative numbers available are  $\pm 1 \times 10^{-499}$ .



# Percentage Calculations in Business

The business percentages (BUS) menu is used to solve four types of problems. Each type of problem has its own menu.



Table 3-1. The Business Percentages (BUS) Menus

Menu	Description
Percent change ( %CHG )	The difference between two numbers (OLD and NEW), expressed as a percentage (%CH) of OLD.
Percent of total ( %T0TL )	The portion that one number (PART) is of another (TO-TAL), expressed as a percentage (%T).
Markup on cost ( MU%C )	The difference between price ( <i>PRICE</i> ) and cost ( <i>COST</i> ), expressed as a percentage of the cost ( $M\%C$ ).
Markup on price ( MU%P )	The difference between price ( <i>PRICE</i> ) and cost ( <i>COST</i> ), expressed as a percentage of the price ( $M\%P$ ).

The calculator retains the values of the BUS variables until you clear them by pressing CLEAR DATA. For example, pressing CLEAR DATA while in the %CHG menu clears *OLD*, *NEW*, and %*CH*.

To see what value is currently stored in a variable, press **RCL** *menu label*. This shows you the value without recalculating it.

# **Using the BUS Menus**

Each of the four BUS menus has three variables. You can calculate any one of the three variables if you know the other two.

1. To display the %CHG, %TOTL, MU%C, or MU%P menu from the MAIN menu, press BUS, then the appropriate menu label. Pressing %CHG, for example, displays:

0.00	
OLD NEW	XCH

- **2.** Store each value you know by keying in the number and pressing the appropriate menu key.
- 3. Press the menu key for the value you want to calculate.

# **Examples Using the BUS Menus**

## **Percent Change (%CHG)**

**Example.** Total sales last year were \$90,000. This year, sales were \$95,000. What is the percent change between last year's sales and this year's?

Keys:	Display:	Description:
BUS %CHG		Displays %CHG menu.
90000 OLD	OLD=90,000.00	Stores 90,000 in OLD.
95000 NEW	NEW=95,000.00	Stores 95,000 in NEW.
%CH	%CHANGE=5.56	Calculates percent change.

What would this year's sales have to be to show a 12% increase from last year? *OLD* remains 90,000, so you don't have to key it in again. Just enter %CH and ask for *NEW*.

12 %CH	%CHANGE=12.00	Stores 12 in %CH.
NEW	NEW=100,800.00	Calculates the value 12% greater than 90,000.

#### **Percent of Total (%TOTL)**

**Example.** Total assets for your company are \$67,584. The firm has inventories of \$23,457. What percentage of total assets is inventory?

You will be supplying values for *TOTAL* and *PART* and calculating %T. This takes care of all three variables, so there is no need to use [CLEAR DATA] to remove old data.

Keys:	Display:	Description:
BUS %TOTL		Displays %TOTL menu.
67584 TOTAL	TOTAL=67,584.00	Stores \$67,584 in TOTAL.
23457 PART	PART=23,457.00	Stores \$23,457 in PART.
×T	%TOTAL=34.71	Calculates percent of total.

#### Markup as a Percent of Cost (MU%C)

**Example.** The standard markup on costume jewelry at Balkis's Boutique is 60%. The boutique just received a shipment of chokers costing \$19.00 each. What is the retail price per choker?

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

#### Markup as a Percent of Price (MU%P)

**Example.** Kilowatt Electronics purchases televisions for \$225, with a discount of 4%. The televisions are sold for \$300. What is the markup of the net cost as a percent of the selling price?

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

Keys:	Display:	Description:
BUS MU%P		Displays MU%P menu.
225 – 4 % Cost	COST=216.00	Calculates and stores net cost in <i>COST</i> .
300 PRICE	PRICE=300.00	Stores 300 in PRICE.
M%P	MARKUP%P=28.00	Calculates markup as a percent of price.
Use \$225 for (	COST and leave PRICE a	lone.
225 созт	COST=225.00	Stores 225 in COST.
M%P	MARKUP%P=25.00	Calculates markup.

# **Sharing 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.



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

**Example: Using Shared Variables.** A food cooperative buys cases of canned soup with an invoice cost of \$9.60 per case. If the co-op routinely uses a 15% markup on cost, for what price should it sell a case of soup?

Keys:	Display:	Description:
BUS Mu%C		Displays MU%C menu.
9.6 COST	COST=9.60	Stores 9.60 in COST.
15 M%C	MARKUP%C=15.00	Stores 15% in <i>M%C</i> .
PRICE	PRICE=11.04	Calculates retail price.

What is the markup on price? Switch menus but keep the same COST and PRICE.

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

# 4

# **Time Value of Money**

The phrase *time value of money* describes calculations based on money earning interest over a period of time. The TVM menu performs compound-interest calculations and calculates (and prints) amortization schedules.

- In compound interest calculations, interest is added to the principal at specified compounding periods, thereby also earning interest. Savings accounts, mortgages, and leases are compound-interest calculations.
- In *simple interest* calculations, the interest is a percent of the principal and is repaid in one lump sum. Simple interest calculations can be done using the <sup>1</sup>% key (page 37). For an example that calculates simple interest using an annual interest rate, see page 182.



## The TVM Menu

The time value of money (TVM) menu does many compound-interest calculations. Specifically, you can use the TVM menu for a series of *cash flows* (money received or money paid) when:

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



#### Figure 4-1. The First Level of TVM

The first level of the TVM menu has five menu labels for variables plus **OTHER**. The **OTHER** key accesses a second-level menu used to specify payment conditions (the *payment mode*) and to call up the AMRT (*amortization*) menu.

12 P/YR		END	MODE
P/YR BEG	END		AMET

Figure 4-2. The Second Level of TVM

<sup>\*</sup> For situations where the amount of the payment varies, use the CFLO (cash flows) menu.

#### Table 4-1. TVM Menu Labels

Menu Label	Description	
	First Level	
N	Stores (or calculates) the <i>total</i> number of payments or compounding periods. <sup>*†</sup> (For a 30-year loan with monthly payments, $N=12\times30=360$ .)	
N	Shortcut for N: Multiplies the number in the display by $P/YR$ , and stores the result in N. (If $P/YR$ were 12, then 30 would set $N=360$ .)	
I%YR	Stores (or calculates) the nominal <i>annual</i> interest rate as a percentage.	
PU	Stores (or calculates) the present value—an initial cash flow or a discounted value of a series of future cash flows ( $PMTs + FV$ ). To a lender or borrower, $PV$ is the amount of the loan; to an investor, $PV$ is the initial investment. If $PV$ paid <i>out</i> , it is <i>negative</i> . $PV$ always occurs at the beginning of the first period.	
РМТ	Stores (or calculates) the dollar amount of each periodic payment. All payments are equal, and no payments are skipped. (If the payments are unequal, use CFLO, not TVM.) Payments can occur at the beginning or end of each period. If <i>PMT</i> represents money paid <i>out</i> , it is <i>negative</i> .	
FV	Stores (or calculates) the future value—a final cash flow or a compounded value of a series of previous cash flows ( $PV$ + $PMT$ s). $FV$ always occurs at the end of the last period. If FV is paid <i>out</i> , it is <i>negative</i> .	
	OTHER EXIT	
	Second Level	
P∠YR	Specifies the number of payments or compounding periods per year. <sup>†</sup> (It must be an integer, 1 through 999.)	
* When a non-integer $N$ (an "odd period") is calculated, the answer must be interpreted carefully. See the savings account example on page 60.		
Calculations using a stored, non-integer $N$ produce a mathematically correct result, but this result has no simple interpretation. The example on page 160 uses the Solver to do a partial-period (non-integer) calculation in which interest begins to accrue prior to the beginning of the first regular payment period.		

† The number of payment periods must equal the number of compounding periods. If this is not true, see page 77. For Canadian mortgages, see page 185.

Menu Label	Description	
	Second Level (Continued)	
BEG	Sets <i>Begin mode</i> : payments occur at the beginning of each period. Typical for savings plans and leasing. (The Begin and End modes do not matter if $PMT=0$ .)	
END	Sets <i>End mode</i> : payments occur at the end of each period. Typical for loans and investments.	
AMRT	Accesses the amortization menu. See page 67.	

 Table 4-1. TVM Menu Labels (Continued)

The calculator retains the values of the TVM variables until you clear them by pressing CLEAR DATA. When you see the first-level TVM menu, pressing CLEAR DATA clears N, I%YR, PV, PMT, and FV. When the second-level menu (OTHER) is displayed, pressing CLEAR DATA resets the payment conditions to 12 PAYR END MODE.

To see what value is currently stored in a variable, press **RCL** *menu label*. This shows you the value without recalculating it.

# **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 called *compounding* (or *payment*) *periods*. Arrows show the occurrence of cash flows (payments in or out). Money received is a positive number (arrow up) and money paid out is a negative number (arrow down).



The correct *sign* (positive or negative) for TVM numbers is essential. The calculations will make sense only if you consistently show *payments out* as *negative* and *payments in* (receipts) as *positive*. Perform a calculation from the

point of view of *either* the lender (investor) *or* the borrower, but not both!



Figure 4-3. A Cash Flow Diagram for a Loan from Borrower's Point of View (End Mode)



#### Figure 4-4. A Cash Flow Diagram for a Loan from Lender's Point of View (End Mode)

Payments occur at either the *beginning* of each period or the *end* of each period. End mode is shown in the last two figures; Begin mode is shown in the next figure.



Figure 4-5. Lease Payments Made at the Beginning of Each Period (Begin Mode)

# **Using the TVM Menu**

First draw a cash-flow diagram to match your problem. Then:

- 1. From the MAIN menu, press FIN TVM .
- **2.** To clear previous TVM values, press **CLEAR DATA**. (Note: You don't need to clear data if you enter new values for *all five* variables, or if you *want* to retain previous values.)
- **3.** Read the message that describes the number of payments per year and the payment mode (Begin, End). If you need to change either of these settings, press **OTHER**.
  - To change the number of payments per year, key in the new value and press PryR . (If the number of payments is different from the number of compounding periods, see "Compounding Periods Different from Payment Periods," page 77.)
  - To change the Begin/End mode, press BEG or END .
  - Press EXIT to return to the primary TVM menu.
- **4.** Store the values you know. (Enter each number and press its menu key.)
- 5. To calculate a value, press the appropriate menu key.

You must give every variable—except the one you will calculate—a value, even if that value is zero. For example, *FV* must be set to zero when you are calculating the periodic payment (*PMT*) required to fully pay back a loan. There are two ways to set values to zero:

- Before storing any TVM values, press CLEAR DATA to clear the previous TVM values.
- Store zero; for example, pressing 0 FV sets FV to zero.

## **Loan Calculations**

Three examples illustrate common loan calculations. (For amortization of loan payments, see page 67.) Loan calculations typically use End mode for payments.

**Example: A Car Loan.** You are financing the purchase of a new 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.) What interest rate would reduce your monthly payment by \$10?



Keys:	Display:	Description:
FIN TVM		Displays TVM menu.
CLEAR DATA	0.00	Clears history stack and TVM variables.
OTHER CLEAR DATA EXIT	12 P/YR END MODE	If needed: sets 12 pay- ment periods per year; End mode.
3 × 12 N	N=36.00	Figures and stores num- ber of payments.
10.5 I%YR	I%YR=10.50	Stores annual interest rate.
7250 – 1500 PV	PV=5,750.00	Stores amount of the loan.
PMT	PMT=-186.89	Calculates payment. Negative value means money to be <i>paid out</i> .

To calculate the interest rate that reduces the payment by \$10, *add* 10 to reduce the negative *PMT* value.

(+ 10 pmt	PMT=-176.89	Stores the reduced pay- ment amount.
I%YR	I%YR=6.75	Calculates the annual in- terest rate.

**Example: A Home Mortgage.** After careful consideration of your personal finances, 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?



Keys:	Display:	Description:
FIN TVM		Displays TVM menu.
CLEAR DATA	0.00	Clears history stack and TVM variables.
OTHER CLEAR DATA EXIT	12 P/YR END MODE	If needed: sets 12 pay- ment periods per year; End mode.
30 <mark>–</mark> N	N=360.00	Pressing first multiplies 30 by 12, then stores this number of payments in $N$ .
11.5 I%YR	I%YR=11.50	Stores annual interest rate.
630 + <u>/</u> РМТ	PMT=-630.00	Stores a <i>negative</i> monthly payment.
PV	PV=63,617.64	Calculates loan amount.
+ 12000 =	75,617.64	Calculates 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?



The problem is done in two steps:

- **1.** Calculate the monthly payment without the balloon (FV=0).
- 2. Calculate the balloon payment after 4 years.

Keys:	Display:		Description:
FIN TVM			Displays TVM menu.
CLEAR DATA	0.00		Clears history stack and TVM variables.
OTHER CLEAR DATA EXIT	12 P/YR	END MODE	If needed: sets 12 pay- ment periods per year; End mode.

**Step 1.** Calculate *PMT* for the mortgage.

25 <mark>- N</mark>	N=300.00	Figures and stores the number of monthly pay- ments in 25 years.
13.8 I%YR	I%YR=13.80	Stores annual interest rate.
75250 PV	PV=75,250.00	Stores amount of the loan.
PMT	PMT=-894.33	Calculates monthly payment.

Step 2. Calculate the balloon payment after 4 years.

894.33 <del>+/_</del> Pmt	PMT=-894.33	Stores <i>rounded PMT</i> value for exact payment amount (no fractional cents).*
4 N	N=48.00	Figures and stores num- ber of payments in 4 years.
FV	FV=-73,408.81	Calculates balloon pay- ment after four years. This amount plus last monthly payment repays the loan.

# **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 grow to \$3,000? Since this account has no regular payments (PMT=0), the payment mode (End or Begin) is irrelevant.

<sup>\*</sup> The *PMT* stored in the previous step is the 12-digit number -894.330557971. The calculation of the balloon payment must use the actual monthly payment amount: the rounded number \$894.33, an exact dollars-and-cents amount.



Keys:	Display:	Description
FIN TVM		Displays TVM menu.
CLEAR DATA	0.00	Clears history stack and TVM variables.
OTHER 1 P/YR EXIT	1 P/YR	Sets one compounding per./yr. (one interest pmt./yr.). Payment mode does not matter.
7.2 I%YR	I%YR=7.20	Stores annual interest rate.
2000 +/_ PV	PV=-2,000.00	Stores amount of deposit.
3000 FV	FV=3,000.00	Stores future account balance in <i>FV</i> .
N	N=5.83	Calculates number of compounding periods (years) for the account to reach \$3,000.

There is no conventional way to interpret results based on a non-integer value (5.83) of *N*. 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 6 years can be calculated as follows:

6 н	N=6.00	Stores a whole number of years in <i>N</i> .	
FV	FV=3,035.28	Calculates account bal- ance after six years.	

**Example: An Individual Retirement Account (IRA).** You opened an IRA on April 15, 1985, with a deposit of \$2,000. Thereafter, you deposit \$80.00 into the account at the end of each half-month. The account pays 8.3% annual interest, compounded semimonthly. How much money will the account contain on April 15, 2000?



Displays TVM menu. It is not necessary to clear data because you do not need to set any of the values to zero.

Sets 24 payment periods per year, End mode.

P/YR				
END				
EXIT	24	P∠YR	END	MODE

TVM

OTHER

2 × 12

15 N	N=360.00	Figures and stores number of deposits in <i>N</i> .
8.3 I%YR	I%YR=8.30	Stores annual interest rate.
2000 +/_ PV	PV=−2,000.00	Stores initial deposit.
80 <del>+/_</del> PMT	PMT=-80.00	Stores semimonthly payment.
FV	FV=63,963.84	Calculates balance in IRA after 15 years.

# **Leasing Calculations**

Two common leasing calculations are 1) finding the lease payment necessary to achieve a specified yield, and 2) finding the present value (capitalized value) of a lease. Leasing calculations typically use "advance payments". For the calculator, this means Begin mode because all payments will be made at the beginning of the period. If there are two payments in advance, then one payment must be combined with the present value. For examples with two or more advance payments, see pages 64 and 187.

**Example: Calculating a Lease Payment.** A new car valued at \$13,500 is to be leased for 3 years. The lessee has the option to purchase the car for \$7,500 at the end of the leasing period. What monthly payments, with one payment in advance, are necessary to yield the lessor 14% annually? Calculate the payments from the lessor's point of view. Use Begin payment mode because the first payment is due at the inception of the lease.



Keys:	Display:	Description:
FIN TVM		Displays TVM menu.
OTHER 12 P/YR BEG EXIT	12 P/YR BEGIN Mode	Sets 12 payment periods per year, Begin mode.
36 N	N=36.00	Stores number of payments.
14 I%YR	I%YR=14.00	Stores annual interest rate.
13500 +⁄_ PV	PV=-13,500.00	Stores car's value in <i>PV</i> . (Money paid out by lessor.)
7500 FV	FV=7,500.00	Stores purchase option value in <i>FV</i> . (Money received by lessor.)
PMT	PMT=289.19	Calculates monthly pay- ment received.

**Example: Present Value of a Lease with Advance Payments and Option to Buy.** Your company is leasing a machine for 4 years. Monthly payments are \$2,400 with two payments in advance. You have an option to buy the machine for \$15,000 at the end of the leasing period. What is the capitalized value of the lease? The interest rate you pay to borrow funds is 18%, compounded monthly.

#### 64 4: Time Value of Money



The problem is done in four steps:

- **1.** Calculate the present value of 47 monthly payments in Begin mode. (Begin mode makes the first payment an advance payment.)
- **2.** Add one additional payment to the calculated present value. Use This adds a second advance payment to the beginning of the leasing period, replacing what would have been the final (48th) payment.
- **3.** Find the present value of the buy option.
- 4. Add the present values calculated in steps 2 and 3.

Keys:	Display:		Description:
FIN TVM			Displays TVM menu.
CLEAR DATA	0.00		Clears history stack and TVM variables.
OTHER 12 P/YR BEG			Sets 12 payment periods per year; Begin mode.
EXIT	12 P∕YR MODE	BEGIN	

47 N	N=47.00	Stores number of payments.
18 I%YR	I%YR=18.00	Stores annual interest rate.
2400 +/_ PMT	PMT=-2,400.00	Stores monthly payment.
PV	PV=81,735.58	Calculates present (capi- talized) value of the 47 monthly payments.
Step 2: Add the	additional advance payme	nt to PV. Store the answer.
+ 2400 =	84,135.58	Calculates present value of all payments.
STO 0	84,135.58	Stores result in register 0.
Step 3: Find th	e present value of the buy	option.
48 N	N=48.00	Stores number of pay- ment periods.
15000 +/_ FV	FV=-15,000.00	Stores amount of the buy option (money paid out).
0 рмт	PMT=0.00	There are no payments.
PV	PV=7,340.43	Calculates present value of the buy option.
Step 4: Add th	e results of step 2 and 3.	

**Step 1:** Find the present value of the monthly payments.

+ RCL 0 =	91,476.00	Calculates present, capi-
		talized value of lease.
### **Amortization (AMRT)**

The AMRT menu (press TVM OTHER AMRT ) displays or prints the following values:

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



Table 4-2. AMRT Menu Labels

Menu Label	Description
#P	Stores the number of payments to be amortized, and calcu- lates an amortization schedule for that many payments. Successive schedules start where the last schedule left off. #P can be an integer from 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 next amortization schedule, which contains <i>#P</i> payments. The next set of payments starts where the previous set left off.
TABLE	Displays a menu for printing an amortization table (schedule).

#### **Displaying an Amortization Schedule**

For amortization calculations, you need to know *PV*, *I*%YR, and *PMT*. If you have just finished doing these calculations with the TVM menu, then skip to step 3.

#### To calculate and display an amortization schedule:\*

- **1.** Press **FIN TWM** to display the TVM menu.
- Store the values for *I*%*YR*, *PV*, and *PMT*. (Press *+*∠ to make *PMT* a negative number.) If you need to calculate one of these values, follow the instructions under "Using the TVM Menu," on page 55. Then go on to step 3.
- **3.** Press OTHER to display the rest of the TVM menu.
- **4.** If necessary, change the number of payment periods per year stored in **P**/YR .
- **5.** If necessary, change the payment mode by pressing BEG or END. (Most loan calculations use End mode.)
- **6.** Press **AMRT**. (If you want to *print* the amortization schedule, go to page 71 to continue.)
- 7. Key in the number of payments to be amortized at one time and press #P . For example, to see a year of monthly payments at one time, set #P to 12. To amortize the entire life of a loan at one time, set #P equal to the total number of payments (N).

If #P = 12, the display would show:



Press to see results

\* Amortization calculations use values of *PV, PMT,* and *INT* rounded to the number of decimal places specified by the current display setting. A setting of **FIX** 2 means that these calculations will be rounded to two decimal places.

- **8.** To display the results, press INT , PRIN , and BAL (or press ▼ to view the results from the stack).
- **9.** To continue calculating the schedule for *subsequent* payments, do **a** or **b**. To start the schedule over, do **c**.
  - **a.** To calculate the next *successive* amortization schedule, with the same number of payments, press **NEXT**.



- **b.** To calculate a subsequent schedule with a *different* number of payments, key in that number and press **#P**.
- **c.** To start over from payment #1 (using the same loan information), press **CLEAR DATA** and proceed from step 7.

**Example: Displaying an Amortization Schedule.** 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. Calculate the amount of the first year's and second year's payments that are applied toward principal and interest.

Then calculate the loan balance after 42 payments ( $3\frac{1}{2}$  years).

Keys:	Display:	Description:
FIN TVM		Displays TVM menu.
12.5 I%YR	I%YR=12.50	Stores annual interest rate.
65000 PV	PV=65,000.00	Stores loan amount.
693.72 +/_ PMT	PMT=-693.72	Stores monthly payment.
OTHER CLEAR DATA	12 P/YR END MODE	If needed: sets 12 pay- ment periods per year; End mode.

AMRT	KEY #PMTS; PRESS {#P}	Displays AMRT menu.
12 #P	#P=12 PMTS: 1-12	Calculates amortization schedule for first 12 pay- ments, but does not display it.
INT	INTEREST=-8,113.16	Displays interest paid in first year.
PRIN	PRINCIPAL=-211.48	Displays principal paid in first year.
BAL	BALANCE=64,788.52	Displays balance at end of first year.
NEXT	#P=12 PMTS: 13-24	Calculates amortization schedule for next 12 payments.
INT	INTEREST=-8,085.15	Displays results for sec- ond year.
PRIN	PRINCIPAL=-239.49	
BAL	BALANCE=64,549.03	

To calculate the balance after 42 payments ( $3\frac{1}{2}$  years), amortize 18 additional payments (42 - 24 = 18):

18 #P	#P=18 PMTS: 25-42	Calculates amortization schedule for next 18 months.
INT	INTEREST= -12,066.98	Displays results for third year.
PRIN	PRINCIPAL=-419.98	
BAL	BALANCE=64,129.05	

#### Printing an Amortization Table (TABLE)

To print an amortization schedule (or "table") do steps 1 through 5 for displaying an amortization schedule (see page 68).

- 6. Press AMRT . Ignore the message KEY #PMTS; PRESS (#P).
- 7. Press TABLE .
- **8.** Key in the payment number of the first payment in the schedule and press **FIRST**. (For instance, for the very first payment, *FIRST*=1.)
- **9.** Key in the payment number of the last payment in the schedule and press LAST .
- **10.** Key in the increment—the number of payments shown at one time—and press **INCR**. (For instance, for one year of monthly payments at a time, INCR = 12.)
- **11.** Press GO .

Values are retained until you exit the TABLE menu, so you can print successive amortization schedules by re-entering only those TABLE values that change.

**Example: Printing an Amortization Schedule.** For the loan described in the previous example (page 69), print an amortization table with entries for the fifth and sixth years. You can continue from the AMRT menu in the previous example (step 7, above) or repeat steps 1 through 6.

Starting from the AMRT menu:

Keys:	Display:	Description:
TABLE	PRINT AMORT TABLE	Displays menu for printing amortization table.
4 × 12 + 1 FIRST	FIRST=49.00	The 49th is the first payment in year 5.
6 × 12 LAST	LAST=72.00	The 72nd is the last payment in year 6.

Each table entry represents 12 payments (1 year).

Calculates and prints amortization schedule shown below.

I%YR= PV= PMT= P∕YR= END MODE	12.50 65,000.00 -693.72 12.00
PMTS:49-60 INTEREST= PRINCIPAL= BALANCE=	-7,976.87 -347.77 63,622.94
PMTS:61-72 INTEREST= PRINCIPAL= BALANCE=	-7,930.82 -393.82 63,229.12

GO

# 5

## **Interest Rate Conversions**

The interest conversion (ICNV) menu converts between nominal and effective interest rates. To compare investments with different compounding periods, their *nominal interest rates* are converted to *effective interest rates*. This allows you, for example, to compare a savings account that pays interest quarterly with a bond that pays interest semiannually.

- The nominal rate is the stated annual interest rate compounded *periodically*, such as 18% per year compounded monthly.
- The effective rate is the rate that, compounded only once (that is, annually), would produce the same final value as the nominal rate. A nominal annual rate of 18% compounded monthly equals an effective annual rate of 19.56%.

When the compounding period for a given nominal rate is one year, then that nominal annual rate *is the same* as its effective annual rate.

### The ICNV Menu



The ICNV menu converts between nominal and effective interest rates, using either:

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

#### **Converting Interest Rates**

#### To convert between a nominal annual interest rate and an effective annual interest rate that is compounded periodically:

- **1.** Press FIN ICNV to display the interest conversions menu.
- **2.** Press **PER** for *periodic*.
- **3.** Key in the number of compounding periods per year and press
- 4. To convert to the effective rate, first key in the nominal rate and press NOM% , then press EFF% .

**5.** To convert to the nominal rate, first key in the effective rate and press EFF%, then press NOM%.

#### To convert between a nominal annual interest rate and an effective annual interest rate that is compounded continuously:

- **1.** Press FIN ICNV to get the interest conversions menu.
- **2.** Press **CONT** for "continuous".
- **3.** To convert to the effective rate, key in the nominal rate and press NOM% , then press EFF% .
- **4.** To convert to the nominal rate, key in the effective rate and press EFF%, then press NOM%.

Values of *EFF*% and *NOM*% are shared between the PER and CONT menus. For example, an effective interest rate in CONT remains stored in *EFF*% when you exit the CONT menu and enter the PER menu. Pressing **CLEAR DATA** in either menu clears *NOM*% and *EFF*% in both.



#### **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 ICNV		Displays ICNV menu.
PER	COMPOUNDING P TIMES∕YR	Displays PER menu.
4 P	P=4.00	Stores number of com- pounding periods per year for bank #1.
6.7 NOM%	NOM%=6.70	Stores nominal annual interest rate for bank #1.
EFF%	EFF%=6.87	Calculates effective inter- est rate for bank #1.
12 P	P=12.00	Stores number of com- pounding periods per year for bank #2.
6.65 NOM%	NOM%=6.65	Stores nominal annual interest rate for bank #2.
EFF%	EFF%=6.86	Calculates effective inter- est rate for bank #2.
EXIT CONT	CONTINUOUS COMPOUNDING	Displays CONT menu. Previous values of <i>NOM%</i> and <i>EFF%</i> are retained.
EFF%	EFF%=6.88	Calculates effective rate for bank #3.

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

#### **Compounding Periods Different from Payment Periods**

The TVM menu assumes that the compounding periods and the payment periods are the same. However, regularly occurring savingsaccount deposits and withdrawals do not necessarily occur at the same time as the bank's compounding periods. If they are not the same, you can adjust the interest rate using the ICNV menu, and then use the adjusted interest rate in the TVM menu. (You can also use TVM if PMT = 0, regardless of the compounding periods.)

- 1. Call up the periodic interest-rate conversion menu ( FIN ICNV PER ).
- **2.** Calculate the effective annual interest rate from the nominal annual interest rate given by the bank.
  - a. Store annual interest rate in NOMX .
  - **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 you will be making per year in P
  - **b.** Press NOM% .
- **4.** Return to the TVM menu (EXIT EXIT TVM ).
- 5. Store the just-calculated nominal interest rate in *I*%YR (press STO IXYR ).
- 6. Store the number of payments or withdrawals per year in **P/YR** and set the appropriate payment mode.
- **7.** Continue with the TVM calculation. (Remember that money paid out is negative; money received is positive.)
  - **a.** *N* is the total number of periodic deposits or withdrawals.
  - **b.** *PV* is the initial deposit.
  - **c.** *PMT* is the amount of the regular, periodic deposit or withdrawal.
  - **d.** *FV* is 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 ICNV menu to convert this to the effective interest rate based on your payment periods. Last, convert the effective rate to the nominal rate based on the bank's compounding periods.

**Example: Balance of a Savings Account.** Starting today, you make monthly deposits of \$25 into an account paying 5% interest compounded daily (365-day basis). At the end of 7 years, how much will you receive from the account?

Keys:	Display:	Description:
FIN ICNV	SELECT COMPOUNDING	
PER	COMPOUNDING P TIMES∕YR	Periodic interest-rate conversion menu.
365 Р	P=365.00	Stores bank's compound- ing periods.
5 NOM%	NOM%=5.00	Stores bank's nominal interest rate.
EFF%	EFF%=5.13	Calculates effective inter- est rate for daily compounding.
12 P	P=12.00	Stores number of depos- its per year.
NOM%	NOM%=5.01	Calculates equivalent nominal interest rate for monthly compounding.
EXIT EXIT	5.01	Switches to TVM menu; NOM% value is still in calculator line

STO IXYR	I%YR=5.01	Stores adjusted nominal interest rate in $I\%YR$ .
OTHER 12 P/YR BEG EXIT	12 P/YR BEGIN MODE	Sets 12 payments per year; Begin mode.
7 N 25 +/_ PMT 0 PV	PV=0.00	Stores 84 deposit peri- ods, \$25 per deposit, and no money before the first regular deposit.
FV	FV=2,519.61	Value of account in 7 years.

If the interest rate were the unknown, you would first do the TVM calculation to get I%YR (5.01). Then, in the ICNV PER menu, store 5.01 as NOM% and 12 as *P* for monthly compounding. Calculate *EFF*% (5.13). Then change *P* to 365 for daily compounding and calculate NOM% (5.00). This is the bank's rate.

# 6

# **Cash Flow Calculations**

The cash flow (CFLO) menu stores and analyzes cash flows (money received or paid out) of *unequal* (*ungrouped*) amounts that occur at regular intervals.\* Once you've entered the cash flows into a *list*, you can calculate:

- The total amount of the cash flows.
- The internal rate of return (IRR%).
- The net present value (NPV), net uniform series (NUS), and net future value (NFV) for a specified periodic interest rate (I%).

You can store many separate lists of cash flows, totaling up to about 700 different flows. The maximum number depends on the amount of available calculator memory.

<sup>\*</sup> You can also use CFLO with cash flows of *equal* amounts, but these are usually handled more easily by the TVM menu.

The CFLO Menu



The CFLO menu creates cash-flow lists and performs calculations with a list of cash flows.

Menu Label	Description
CALC	Accesses the CALC menu to calculate TOTAL, IRR%, NPV, NUS, NFV.
INSR	Allows you to insert cash flows into a list.
DELET	Deletes cash flows from a list.
NAME	Allows you to name a list.
GET	Allows you to switch from one list to another or create a new list.
#T?	Turns the prompting for #TIMES on and off.

Table 6-1. CFLO Menu Labels

To see the calculator line when this menu is in the display, press INPUT once. (This does not affect number entry.)

To see this menu when the calculator line is in the display, press **EXIT**.

### **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. A typical series of cash flows is one of two types:

Ungrouped cash flows. These occur in series of cash flows without "groups" of equal, consecutive flows.\* Because each flow is different from the one before it, the number of times each flow occurs is one.



#### Figure 6-1. Cash Flows (Ungrouped)

The horizontal timeline is divided into equal compounding periods. The vertical lines represent the cash flows. For money received, the line points up (positive); for money paid out, the line points down (negative). In this case, the investor has invested \$700. This investment has generated a series of cash flows, starting at the end of the first period. Notice that there is no cash flow (a cash flow of zero) for period five, and that the investor *pays* a small amount in period six.

\* Any cash flow series can be treated as an ungrouped one if you enter each flow individually.

Grouped cash flows. These occur in a series containing "groups" of equal, consecutive flows. Consecutive, equal cash flows are called grouped cash flows. The series shown here is grouped into two sets of consecutive, equal cash flows:



**Figure 6-2. 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. For every cash flow you enter, the calculator prompts you to indicate how many times (*#TIMES*) it occurs.

#### **Creating a Cash-Flow List**

To use CFLO, be sure your cash flows are occurring at regular intervals and at the *end* of each period.\* If a period is skipped, enter zero for its cash flow. If there are any *grouped* (consecutive and equal) cash flows, the *#TIMES* prompting makes entering the data easier.

<sup>\*</sup> If the cash flows occur at the beginning of each period, then combine the first flow with the initial flow (which can increase or decrease the flow), and move each cash flow up one period. (Remember: a payment made at the beginning of period 2 is equivalent to the same payment made at the end of period 1, and so on. Refer to pages 53–55.)

#### **Entering Cash Flows**

To enter cash flows into a CFLO list:

Press FIN CFLO . You will see either FLOW(0)=? if the current list is empty, or FLOW(1 or more)=? if the list is not empty. This is the *bottom* of the current list.



- 2. If the list is *not* empty, you can do either **a** or **b**:
  - a. Clear the list by pressing CLEAR DATA YES (see also page 89.)
  - **b.** Get a new list by pressing GET **\*NEW**. (The old list must be named first. Press **NRME** or see page 87.)
- **3.** If the cash flows are *ungrouped* (that is, they are all different), then press **#T?** to turn **#TIMES** PROMPTING OFF. For grouped cash flows, leave this prompting on. (For more information, see "Prompting for **#TIMES**," next page.)
- **4.** Key in the value of the initial cash flow, *FLOW(0)* (remember that money paid out is negative—use <sup>+</sup>/<sub>↓</sub> to change the sign), and press INPUT.\*
- 5. After briefly showing FLOW(0), the display shows FLOW(1)=?. (To view FLOW(0) longer, hold down INPUT before releasing it.) Key in the value for FLOW(1) and press INPUT. The prompt for the next item appears.

<sup>\*</sup> You can do calculations with a number before entering it. This does not interfere with the list. When you press INPUT, the evaluated expression or number is entered into the list.

- 6. For grouped cash flows: The display now shows #TIMES(1)=1. If it does not, press EXIT #T? to turn the #TIMES prompting on. (See "Prompting for #TIMES," below.) #TIMES is the number of consecutive occurrences of FLOW(1). #TIMES has been automatically set to 1, and 1.00 is displayed on the calculator line. Do either a or b:
  - a. To retain the value 1 and go on to the next flow, press [INPUT] (or ▼).
  - **b.** To change *#TIMES*, key in the number and press **INPUT**.\*



- **7.** Continue entering each cash flow and, for grouped flows, the number of times it occurs. The calculator recognizes the end of the list when a flow is left blank (no value is entered).
- **8.** Press **EXIT** to end the list and restore the CFLO menu. You can now proceed to correct the list, name the list, get another list, or do calculations with the values.

Use these same instructions to enter additional lists.

**Prompting for #TIMES (T?).** When the calculator displays #TIMES(1)=1, it is *prompting* you for the number of times the current flow occurs. If *all* your cash flows are different (*#TIMES* always 1), then you don't need the **#TIMES** prompt. You can turn the prompting for *#TIMES* on and off by pressing **#T?** in the CFLO menu. This produces a brief message: either **#TIMES** PROMPTING: OFF, or **#TIMES** PROMPTING: ON.

While prompting is off, all cash flows you enter will have #TIMES = 1.

<sup>\*</sup> The maximum #TIMES for each cash flow is 999.

When you are viewing a cash-flow list with the *#TIMES* prompting off, the calculator displays only those *#TIMES* values that are *not* 1.

The *#TIMES* prompting is usually *on*, because it is automatically turned on whenever you clear or get a cash-flow list.

**Example: Entering Cash Flows.** Enter the following ungrouped cash flows in a list and find the percentage internal rate of return (IRR).

	0: \$-500 2: \$ 22	75
	1: 125 3: 20	00
Keys:	Display:	Description:
FIN CFLO		
CLEAR DATA	CLEAR THE LIST?	Asks for confirmation.
YES	FLOW(0)=?	Clears data from list and prompts for initial flow.
#T?	#TIMES PROMPTING: OFF	Sets prompting off be- cause it is not needed.
500 (+/_) (INPUT)	FLOW(1)=? -500.00	Enters initial flow; then immediately prompts for next flow.
125 [INPUT]	FLOW(2)=? 125.00	Enters <i>FLOW(1)</i> ; prompts for next flow.
275 [INPUT]	FLOW(3)=? 275.00	Enters <i>FLOW</i> (2); prompts for next flow.
200 INPUT	FLOW(4)=? 200.00	Enters <i>FLOW</i> (3); prompts for next flow
EXIT CALC	NPV, NUS, NFV NEED I%	Ends list and displays CALC menu.
IRR%	IRR%=9.06	Calculates IRR.

#### **Viewing and Correcting the List**

To display a particular list, use GET (see page 88).

The  $\blacktriangle$  and  $\bigtriangledown$  keys move up and down one number at a time.

**Changing or Clearing a Number.** To change a number after it's been entered: display the number, key in the new value, and press **INPUT**.

Use this same method to clear a number to zero. (Do not press CLR or (4), which clear the calculator line, not the cash-flow entry.)

**Inserting Cash Flows into a List.** Insertion occurs *before (above)* the current flow. Pressing **INSR** inserts a zero cash flow and renumbers the rest of the list. You can then enter a new cash flow and its *#TIMES*.

For example, if *FLOW(6)* is in the display, pressing **INSR** puts a new, zero flow between the previously numbered *FLOW(5)* and *FLOW(6)*.

**Deleting Cash Flows from a List.** Pressing **DELET** deletes both the current flow and its *#TIMES*.

#### Copying a Number from a List to the Calculator Line

To copy a number from the list into the calculator line, use ▼ or ▲ to display the number, then press **RCL INPUT**.

#### Naming and Renaming a Cash-Flow List

A new list has no name. You may name it before or after filling the list, but you *must* name it in order to store another list.

To name a list:

**1.** Press NRME from the CFLO menu.

- **2.** Use the ALPHA menu to type a name. (The ALPHA and AL-PHA-Edit menus are covered on pages 27–29.) To clear a name, press CLR.
- **3.** Press INPUT.

The name can be up to 22 characters long and include any character except:  $+ - \times \div$  ( ) < > := space \*

But only the first three to five characters (depending on letter widths) of the name are used for a menu label. Avoid names with the same first characters, since their menu labels will look alike.

Viewing the Name of the Current List. Press NAME , then EXIT.

#### **Starting or GETting Another List**

When you press **CFLO**, the cash-flow list that appears is the same as the last one used.

To start a new list or switch to a different one, the current list must be named or cleared. Then:

- **1.** Press **GET**. The GET menu contains a menu label for each named list plus **\*NEW**.
- 2. Press the key for the desired list. ( \*NEW brings up a new, empty list.)

 $<sup>^{*}</sup>$  CFLO does accept these exceptional characters in list names, but the Solver functions SIZEC, FLOW, and  $^{#}$ T do not.

#### **Clearing a Cash-Flow List and Its Name**

To clear a list's numbers and name:

- **1.** Display the list you want to clear, then press **CLEAR DATA YES**. This removes the numbers.
- 2. If the list is named, you'll see ALSO CLEAR LIST NAME? Press YES to remove the name. Press NO to retain the name with an empty list.

To remove just one value at a time from a list, use DELET .

# Cash-Flow Calculations: IRR, NPV, NUS, NFV

Once you have entered a list of cash flows, you can calculate the following values in the CALC menu.

- Sum (TOTAL).
- Internal rate of return (IRR%). This is a *periodic* rate of return. To calculate an *annual* nominal rate when the period is not a year, multiply the IRR% by the number of periods per year.

If you want the *IRR*% as an *effective* annual rate, then use the FIN ICNV menu to convert from the nominal annual rate to the effective annual rate.

■ Net present value (*NPV*), net uniform series (*NUS*), and net future value (*NFV*) for a specified, *periodic* interest rate, *I*%.

#### Table 6-2. The CALC Menu for CFLO Lists

Menu Label	Description
TOTAL	Calculates the sum of the cash flows.
IRR% *	Calculates the <i>internal rate of return</i> —the interest (discount) rate at which the net present value of the cash flows equals zero.
1%	Stores the <i>periodic interest rate</i> , expressed as a percent- age (sometimes called <i>cost of capital</i> , <i>discount rate</i> , or <i>required rate of return</i> ).
NPV	Given 1%, calculates the net present value—the present value of a series of cash flows.
NUS	Given <i>I</i> %, calculates the <i>net uniform</i> series—the dollar amount of constant, equal cash flows having a present value equivalent to the net present value.
NFV	Given <i>I</i> %, calculates the <i>net future value</i> of a series of cash flows by finding the future value of the net present value.
* The calculations for internal rate of return are complex and may take a relatively long time. To interrupt the calculation, press any key. In certain cases, the calculator displays a mes- sage indicating that the calculation cannot continue without further information from you, or that there is no solution. Refer to appendix B for additional information about calculating <i>URP</i> %	

**About the Internal Rate of Return (IRR%).** A "conventional investment" is considered attractive if *IRR*% exceeds the cost of capital. A conventional investment meets two criteria—(1) the sequence of cash flows changes sign only once, and (2) the sum (*TOTAL*) of the cash flows is positive.

Remember that the calculator determines a periodic IRR%. If the cash flows occur monthly, then IRR% is a monthly value, too. Multiply it by 12 for an annual value.

**Example: Calculating IRR and NPV of an Investment.** An investor makes an initial investment of \$80,000, and expects returns over the next five years as illustrated below.



Calculate the total of the cash flows and the internal rate of return of the investment. In addition, calculate the net present value and net future value, assuming an annual interest rate of 10.5%.

Start the problem with an empty cash-flow list. Since the cash flows are ungrouped, each one occurs just once. Turn off the *#TIMES* prompt to make cash-flow entry faster.

Keys:	Display:	Description:
FIN CFLO		Displays current cash- flow list and CFLO menu keys.
YES OT GET *NEW	FLOW(0)=?	Clears current list or gets a new one. The empty list prompts for its initial cash flow.
#T?	#TIMES PROMPTING: OFF	<i>Briefly</i> shows the status of <b>#T</b> , then returns to the list. With prompt- ing off, all cash flows are assumed to occur just

once.

80000 +/_) [INPUT]	FLOW(1)=? -80,000.00	Prompts for next cash flow. Calculator line shows last number entered.
5000 (INPUT)	FLOW(2)=?	Stores \$5,000 for <i>FLOW(1),</i> prompts for next flow.
4500 INPUT	FLOW(3)=?	Stores FLOW(2).
5500 INPUT	FLOW(4)=?	Stores FLOW(3).
4000 INPUT	FLOW(5)=?	Stores FLOW(4).
115000 INPUT	FLOW(6)=?	Stores final cash flow and shows end of list.
EXIT CALC Total	TOTAL=54,000.00	Calculates sum of the cash flows.
IRR%	IRR%=11.93	Calculates internal rate of return.
10.5 1%	I%=10.50	Stores periodic interest rate.
NPV	NPV=4,774.63	Calculates NPV.
NEV	NFV=7,865.95	Calculates NFV.

Now calculate the net present value at an interest rate of 10.5% if cash flow #4 is reduced to \$1,000.

EXIT	FLOW(6)=?	Displays the bottom of the list.
	FLOW(4)=4,000.00	Moves to cash flow #4.
1000 [INPUT]	FLOW(5)=115,000.00	Changes cash flow #4 to \$1,000.
EXIT CALC	NPV=2,762,43	Calculates new NPV.

**Example: An Investment with Grouped Cash Flows.** You are considering an investment that requires a cash outlay of \$9,000, with the promise of monthly cash flows as shown. Calculate *IRR%*. Also find *NPV* and *NFV* at an annual interest rate of 9%.



Since some of these cash flows are *grouped* (consecutive and equal), the *#TIMES* prompting must be on so you can specify a number other than 1.

Group Number	Amount	Number of Times
Initial	-9,000	_
1	500	3
2	1,000	4
3	0	1
4	1,500	3

Keys:	Display:	Description:
FIN CFLO		Current cash-flow list and CFLO menu.
YES	FLOW(0)=?	Clears current list. <i>#TIMES</i> prompting is turned on.
9000 +/_ INPUT	FLOW(1)=?	Stores the initial cash flow.
500 [INPUT]	#TIMES(1)=1	Stores FLOW(1) and prompts for #TIMES(1).
3 [INPUT]	FLOW(2)=?	<i>FLOW(1)</i> occurs 3 times; prompts for next cash flow.
1000 INPUT 4 INPUT	FLOW(3)=?	Stores <i>FLOW(2)</i> four times.
0 [INPUT] [INPUT]	FLOW(4)=?	Stores <i>FLOW</i> (3) one time (the 1 is automatically entered).
1500 INPUT 3 INPUT	FLOW(5)=?	Stores <i>FLOW(4)</i> three times.
EXIT CALC		Displays the CALC menu.
IRR%	IRR%=1.53	Calculates monthly <i>IRR%</i> .
9 ÷ 12 1%	I%=0.75	Stores the periodic, monthly interest rate.
NPV	NPV=492.95	Calculates NPV.
NFV	NFV=535.18	Calculates NFV.

**Example: An Investment with Quarterly Cash 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



Calculate the annual rate of return for this investment. (The prompting for *#TIMES* should be on.)

Keys:	Display:	Description:
FIN		Current cash-flow list.
CFLO		
CLEAR DATA		Clears the current list or
YES		gets a new one. This sets
or		the #TIMES prompting
GET		on.
*NEW	FLOW(0)=?	

20000 +/_ INPUT	FLOW(1)=?	Stores the initial cash flow.
500 [INPUT]	#TIMES(1)=1	Stores <i>FLOW</i> (1), then prompts for number of times this flow occurs.
4 INPUT	FLOW(2)=?	<i>FLOW(1)</i> occurs four times.
1000 INPUT 4 INPUT 2000 INPUT 4 INPUT 3000 INPUT 4		Stores <i>FLOW(2), FLOW(3)</i> and <i>FLOW(4),</i> and the number of times each flow occurs.
INPUT	FLOW(5)=?	
EXIT CALC IRR%	IRR%=2.43	Calculates quarterly rate of return.
× 4 =	9.72	Calculates nominal an- nual rate of return from quarterly rate.

#### **Doing Other Calculations with CFLO Data**

If you would like to do other calculations with cash flows besides those in the CALC menu, you can do so by writing your own Solver equations. There are Solver functions that can access data stored in CFLO lists, and there is a summation function that can combine all or part of the values stored in specific lists.

Refer to "Accessing CFLO and SUM Lists from the Solver" in chapter 11.

# 7

### Bonds

The BOND Menu

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.
- Coupon payments: semi-annual or annual. Most U.S. bonds are semi-annual.



Pressing BOND shows you the BOND menu and the type of bond currently specified: 30/360 or A/A; SEMIANNUAL or ANNUAL.

Menu Label	Description
TYPE	Displays a menu of bond types: 30/360 or actual/actual, semi-annual or annual.
SETT	Stores the settlement (purchase) date according to the current date format ( <i>MM.DDYYYY</i> or <i>DD.MMYYYY</i> ; see page 132).
MAT	Stores the maturity date <i>or</i> call date according to 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. For a yield to <i>maturity</i> , make sure <i>CALL</i> equals 100. (A bond at maturity has a "call" value that is 100% of its face value.)
YLD%	Stores or calculates the yield (as an annual percentage) to maturity <i>or</i> yield to call date.
PRICE	Stores or calculates the price per \$100 face value.
ACCRU	Calculates the interest accrued from the last coupon-pay- ment date until the settlement date, per \$100 face value.

#### Table 7-1. BOND Menu Labels

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 and all other variables to zero.

To see the value currently stored in a variable, press RCL menu label.

#### **Doing Bond Calculations**

Remember that 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: press FIN BOND .
- **2.** Press CLEAR DATA. This sets CALL=100.
- **3.** Define the type of bond. If the message in the display does not match the type you want, press **TYPE**.



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

Press EXIT to restore the BOND menu.

- **4.** Key in the settlement date (*MM.DDYYYY* or *DD.MMYYYY* depending on the date format; see chapter 10) and press **SETT**.
- 5. Key in the maturity date or call date and press MAT .
- 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. (See step 3.)
- 8. To calculate a result, first press MORE to access the remaining menu labels. Do either **a** or **b**:
  - **a.** Key in the yield and press YLD%. Press PRICE to calculate the price.
  - **b.** Key in the price and press **PRICE**. Press **YLD**<sup>\*</sup> to calculate the yield.

To calculate the accrued interest, press ACCRU. The *total* amount owed the seller is PRICE + ACCRU, that is: PRICE + ACCRU =.

**Calculating Fractional Values.** When given a fractional value that must be entered in decimal form, do the arithmetic and then store the result *directly* into a variable. Do not clear the arithmetic and then retype the result before storing it—this is an unnecessary step that can cause incorrect answers due to rounding. See how the following example stores 8<sup>3</sup>/<sub>8</sub> in *YLD*%.

**Example: Price and Yield of a Bond.** What price should you pay on August 10, 1987 for a  $6^{3}/_{4}$ % U.S. Treasury bond that matures on May 1, 2002 if you wish a yield of  $8^{3}/_{8}$ ? 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		Since there is no call on this bond, set $CALL=100$ by clearing variables.
TYPE A/A SEMI EXIT	A∕A SEMIANNUAL	Sets bond type, if necessary.
8.101987 SETT	SETT= 08/10/1987 MON	Stores settlement (pur- chase) date.
5.012002 MAT	MAT=05/01/2002 WED	Stores maturity date.
6.75 CPN%	CPN%=6.75	Stores annual coupon rate.
MORE		Stores desired yield (dis- played rounded to two decimal places).*
3 ÷ 8 + 8 YLD%	YLD%=8.38	Shows full precision of stored number.

\* To see the full precision of the number, press SHOW.

PRICE	PRICE=86.38	Result: price is \$86.38 per \$100 face value.
+ ACCRU	86.38+1.85	Adds accrued interest owed the seller.
=	88.23	Net price.

Suppose that the market quote for the bond is 88<sup>1</sup>/<sub>4</sub>. What yield does it represent?

88.25 PRICE	PRICE=88.25	Stores quoted price.
YLD%	YLD%=8.13	Result: yield to maturity.

**Example: A Bond with a Call Feature.** What is the price of a 6% corporate bond maturing on March 3, 2007 and purchased on May 2, 1988 to yield 5.7%? It is callable on March 3, 1991 (a coupon date), at a value of 102.75. What is the yield to the call date? Use a 30/360 calendar with semi-annual coupon payments.

Keys:	Display:	Description:
FIN BOND CLEAR DATA		Displays BOND menu, clears variables.
TYPE 360 SEMI EXIT	30/360 SEMIANNUAL	Sets bond type, if necessary.
5.021988 SETT	SETT= 05/02/1988 MON	Stores purchase date ( <i>MM.DDYYYY</i> format).
3.032007 MAT	MAT=03/03/2007 SAT	Stores maturity date.
6 CPN%	CPN%=6.00	Stores annual coupon rate.
MORE 5.7 YLD%	YLD%=5.70	Stores yield.

PRICE	PRICE=103.43	Calculates price.
MORE 3.031991 Mat		Changes maturity date to call date and stores a call value.
102.75 CALL	CALL=102.75	
MORE		Calculates yield to call.
YLD%	YLD%=5.58	

**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 and will mature on June 30, 2000, and has a yield to maturity of 10%.

Keys:	Display:	Description:
F I N BOND CLEAR DATA		Clears BOND variables, setting <i>CALL</i> to 100.
TYPE 360 SEMI EXIT	30/360 SEMIANNUAL	Sets type if necessary (check the display).
5.191986 SETT	SETT= 05/19/1986 MON	Purchase date ( <i>MM.DDYYYY</i> format).
6.302000 МАТ	MAT=06/30/2000 FRI	Maturity date.
О СРМ%	CPN%=0.00	Coupon rate is zero.
MORE 10 YLD%	YLD%=10.00	Yield to maturity.
PRICE	PRICE=25.23	Calculates price.
## 8

## Depreciation

The DEPRC (*depreciation*) menu calculates depreciation values and remaining depreciable values 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



Pressing DEPRC displays the DEPRC menu.

#### Table 8-1. DEPRC Menu Labels

Menu Label or 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 <i>BASIS</i> and <i>ACRS%</i> . (The values in <i>SALV</i> , <i>LIFE</i> , <i>FACT%</i> , and <i>YR#</i> do not matter.)
YR#	Stores the number of the year for which you want the depreciation (1, 2, etc.).
FACT%	Stores the declining-balance factor as a percentage of the straight-line rate. <i>This is for the DB method only.</i> For example, for a rate $1^{1/4}$ times (125%) the straight-line rate, enter 125.
DB	Calculates the declining-balance depreciation for the year.
SOYD	Calculates the sum-of-the-years'-digits depreciation for the year.
SL	Calculates the straight-line depreciation for the year.
	Displays the remaining depreciable value, RDV, after you have pressed DB , SOYD , or SL .

The calculator retains the values of the DEPRC variables until you clear them by pressing CLEAR DATA while the DEPRC menu is displayed.

To see the value currently stored in a variable, press [RCL] menu label.

## **Doing Depreciation Calculations**

#### **DB, SOYD, and SL Methods**

#### To calculate the depreciation for an asset:\*

- 1. Display the DEPRC menu: press FIN DEPRC.
- **2.** 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 .
- **3.** Press MORE for the rest of the DEPRC menu.
- **4.** Key in the number for the year of depreciation you want to calculate (1, 2, 3, etc.) and press YR# .
- **5.** If you are using the declining-balance method, enter the DB factor (a percentage) and press FRCT%.
- **6.** Press **DB**, **SOYD**, or **SL** to calculate the appropriate depreciation.
- To see the remaining depreciable value (basis salvage value accumulated depreciation), press ▼.
- **8.** To calculate the depreciation for another year, just change YR# and press DB , SOYD , or SL again.

**Example: Declining-Balance Depreciation.** 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). For comparison, find the straight-line depreciation, as well.

<sup>\*</sup> The calculated values of *RDV*, *DB*, *SOYD*, and *SL* are rounded internally to the number of decimal places specified by the current display setting. A setting of **FIX** 2 means that these values will be rounded internally to two decimal places.

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	DB=4,000.00	Depreciation in first year. (Salvage value ignored at this point.)
	RDV=5,500.00	Remaining depreciable value after first year ( <i>BASIS</i> – <i>SALV</i> – 4,000).
2 YR# DB	DB=2,400.00	Depreciation in second year.
	RDV=3,100.00	Remaining depreciable value after second year.
3 YR# DB	DB=1,440.00	Depreciation in third year.
	RDV=1,660.00	Remaining depreciable value after third year.
SL	SL=1,900.00	Straight-line depreciation for each year.
	RDV=3,800.00	Remaining depreciable value after third year us- ing SL.

## The ACRS Method

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

- 1. 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<sup>\*</sup>.
- 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

#### **Partial-Year Depreciation**

When the acquisition date of an asset does not coincide with the start of the tax or fiscal year, then the amounts of depreciation in the first and last years are computed as fractions of a full year's depreciation. Except in SL, the intermediate years are computed as sums of fractions. This does not apply to the ACRS method.

Suppose you acquired an asset in October and wanted to depreciate it for 3 years. (Your fiscal year begins January 1st.) The depreciation schedule would affect parts of 4 years, as shown in the illustration. The 3 months from October to December equal <sup>1</sup>/<sub>4</sub> year.



For SL depreciation, partial-year calculations are easy: calculate the SL value, then use  $\frac{1}{4}$  of that value for the first year, the full amount the second and third years, and  $\frac{3}{4}$  of that amount the fourth year.

For DB and SOYD depreciation, each year's depreciation value is different, as shown in the table:

Calendar Year	Depreciation Value
1 (OctDec.)	$^{1/_{4}}$ × year 1
2	(3/4 $\times$ year 1) + (1/4 $\times$ year 2)
3	(3/4 $\times$ year 2) + (1/4 $\times$ year 3)
4 (JanSept.)	$^{3/_{4}}$ × 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 year. Assume the first depreciation year was 11 months long.

Keys:	Display:	Description:
FIN DEPRC		Displays DEPRC menu.
12000 BASIS 500 SALV 10 LIFE MORE		Stores known values.
3 YR#	YR#=3.00	
SOYD	SOYD=1,672.73	Calculates depreciation for year 3.
÷ 12 = STO 1	139.39	Stores 1 month's depreci- ation from year 3.
4 YR# Soyd	SOYD=1,463.64	Calculates depreciation for year 4.
× 11 ÷ 12 =	1,341.67	Figures 11 months' depreciation from year 4.
+ RCL 1 =	1,481.06	Figures total depreciation for year 4.



## **Running Total and** Statistics

The SUM menu stores and statistically analyzes sets of numbers. As you enter the numbers, the calculator displays their running total. Once you've entered the numbers into a *list*, you can:

- Calculate the mean, median, standard deviation, and range.
- Display the largest and smallest number in the list.
- Sort the list from smallest number to largest number.

With two lists of numbers, you can:

- 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*.)
- Calculate the weighted mean and grouped standard deviation.
- Find the summation statistics ( $\Sigma x$ ,  $\Sigma x^2$ ,  $\Sigma y$ ,  $\Sigma y^2$ ,  $\Sigma xy$ ).

You can store many separate lists of numbers in SUM, totaling up to about 840 items. The maximum number depends on the amount of available calculator memory.

## The SUM Menu



The SUM menu creates lists of numbers and performs calculations with a SUM list.

Table 9-1. SUM Menu La	ibels
------------------------	-------

Menu Label	Description
CALC	Accesses the CALC menu to calculate the total, mean, me- dian, standard deviation, range, minimum, maximum, sorting, and linear regression (including weighted mean and summation statistics).
INSR	Allows you to insert numbers into the list.
DELET	Deletes numbers from the list.
NAME	Allows you to name the list.
GET	Allows you to switch from one named list to another or to create a new list.
TOTAL	Displays the total of all the items in the list.

To see the calculator line when this menu is in the display, press INPUT once. (This does not affect number entry.)

To see this menu when the calculator line is in the display, press **EXIT**.

## **Creating a SUM List**

To keep a running total of a list of numbers or do statistical calculations with sets of data, first create a SUM list of the values.

#### **Entering Numbers and Viewing the TOTAL**

To enter numbers into a SUM list:

 Press SUM . You'll see ITEM(1)=? if the current list is empty, or ITEM(2 or more)=? if the list is not empty. This is the *bottom* of the current list.

> ITEM(1)=? Calc Insr Gelet Name Get Total

- **2.** If the list is empty, start filling it (step 3). If the current list is *not* empty, you can do either **a** or **b**:
  - a. Clear the list by pressing CLEAR DATA YES (see also page 116.)
  - **b.** Get a new list by pressing GET **\*NEW**. (The old list must be named first. Press NAME or see page 115.)
- **3.** Key in the value of the first item, *ITEM(1)* (press +/\_ for a negative number), and press INPUT.\* (To view *ITEM(1)* longer, hold down INPUT before releasing it.)

After briefly showing ITEM(1), the display shows

ITEM(2)=? TOTAL=number *TOTAL* is the updated, running *TOTAL* of all the numbers in the list (only one number, so far).

- **4.** To enter *ITEM*(2), key in the value and press **INPUT**. The prompt for *ITEM*(3) and the new, updated total appear.
- **5.** Continue entering values for *ITEM(3), ITEM(4),* etc. The calculator recognizes the end of the list when an item is left blank (no value is entered).
- **6.** Press **EXIT** to end the list and restore the SUM menu. You can now proceed to correct the list, name the list, get another list, or do statistical calculations.

Use these same instructions to enter additional lists.

#### **Viewing and Correcting the List**

To display a particular list, use **GET** (see page 116).

The  $\blacktriangle$  and  $\bigtriangledown$  keys move up and down the list one number at a time.  $\blacksquare \blacktriangle$  and  $\blacksquare \bigtriangledown$  display the beginning and end of the list.

**Changing or Clearing a Number.** To change a number after it's been entered: display the number, key in the new value, and press INPUT.

Use the same method to clear a number to zero. (Do not press CLR) or (, which clears the calculator line.)

**Inserting Numbers into a List.** Insertion occurs *before* (or *above*) the current entry. Pressing **INSR** inserts a zero item and renumbers the rest of the list. You can then enter a new value.

For example, if *ITEM(6)* is in the display, pressing **INSR** puts a new, zero item between the previously numbered *ITEM(5)* and *ITEM(6)*.

<sup>\*</sup> Remember that you can do calculations with a number before entering it. This does not interfere with the list. Whenever you press INPUT, the number (or evaluated expression) in the calculator line is entered into the list. If you need to use the MATH menu, just press MATH, do the calculation, then press EXIT to return to where you were in SUM.

**Deleting Numbers from a List.** Pressing **DELET** deletes the current item.

**Example: Updating a Checkbook.** On May 31, your checking account balance was \$267.82. The transactions for the first 10 days in June are:

Date	Transaction	Amount	Date	Transaction	Amount
6/1	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 *		
CLEAR DATA YES	ITEM(1)=?	Displays empty SUM list.
267.82 [INPUT]	ITEM(2)=? TOTAL=267.82	Enters beginning balance and shows running total.
837.42 INPUT	ITEM(3)=? TOTAL=1,105.24	Enters deposit on 6/1.

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

#### 114 9: Running Total and Statistics

368.23 +/_ INPUT 45.36 +/_ INPUT 128.90 +/_ INPUT 65.35 +/_ INPUT		Enters remaining transactions.
55.67 [INPUT]	ITEM(8)=? TOTAL=553.07	
EXIT	ITEM(8)=?	Ends list and displays SUM menu again.

#### Copying a Number from a List to the Calculator Line

To copy a number from the list into the calculator line, use  $\checkmark$  or  $\blacktriangle$  to display the number, then press **RCL INPUT**.

#### Naming and Renaming a SUM List

A new list has no name. You may name it before or after filling the list, but you *must* name it in order to store another list.

To name a list:

- **1.** Press NAME from the SUM menu.
- **2.** Use the ALPHA menu to type in a name. (The ALPHA and AL-PHA-Edit menus are covered on pages 27–29.) To clear a name, press CLR.
- **3.** Press INPUT.

The name can be up to 22 characters long and include any character except:  $+ - \times \div$  ( ) < > := space \*

<sup>\*</sup> SUM does accept these exceptional characters in list names, but the Solver functions SIZES and ITEM do not.

But only the first three to five characters (depending on letter widths) of the name are used for a menu label. Avoid names with the same first characters, since their menu labels will look alike.

Viewing the Name of the Current List. Press NAME , then EXIT.

#### **Starting or GETting Another List**

When you press **SUM**, the SUM list that appears is the last one used.

To start a new list or switch to a different one, the current list must be named or cleared. Then:

- **1.** Press **GET**. The GET menu contains a menu label for each named list plus **\*NEW**.
- 2. Press the key for the desired list. ( \*NEW brings up a new, empty list.)

## **Clearing a SUM List and Its Name**

To clear a list's numbers and name:

- **1.** Display the list you want to clear, then press CLEAR DATA YES . This removes the numbers.
- 2. If the list is named, you'll see ALSO CLEAR LIST NAME? Press YES to remove the name. Press NO to retain the name with an empty list.

To remove just one value at a time from a list, use DELET .

## **Doing Statistical Calculations (CALC)**

Once you have entered a list of numbers, you can calculate the following values.

- **For one variable:** the total, mean, median, standard deviation, range, minimum, and maximum. You can also sort the numbers in order of increasing value.
- For two variables: *x*-estimates and *y*-estimates (this is also called *forecasting*), the correlation coefficient for different types of curves (this is *curve-fitting*), the slope and *y*-intercept of the line, and summation statistics. You can also find the weighted mean and the grouped standard deviation.

## **Calculations with One Variable**

The CALC menu calculates the following statistical values using one SUM list.

Menu Key	Description
TOTAL	Calculates the sum of the numbers in the list.
MEAN	Calculates the arithmetic mean (average).
MEDN	Calculates the median.
STDEV	Calculates the standard deviation.*
RANG	Calculates the difference between the largest and smallest number.
	MORE
MIN	Finds the smallest (minimum) number in the list.
MAX	Finds the largest (maximum) number in the list.
SORT	Sorts the list in ascending order.
FRCST	Displays a series of menus for calculations with two variables for curve fitting, estimation, weighted mean and grouped standard deviation, and summation statistics.
* The calculator finds the <i>sample</i> standard deviation. The formula 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 <i>true population standard deviation</i> can be computed by calculating the mean of the original list, placing that value into the list, and then calculating the standard deviation.	

Table 9-2. The CALC Menu for SUM Lists

**Example: Mean, Median, and Standard Deviation.** Suppose your 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

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

	Displays current SUM list and SUM menu keys.
	Clears current list or gets a new one.
ITEM(1)=?	
ITEM(2)=? TOTAL=340.00	Stores May's phone bill; shows total.
ITEM(3)=? TOTAL=515.00	Stores June; updates total.
ITEM(7)=?	Stores phone bills for July–October and keeps a running total.
	<pre>ITEM(1)=? ITEM(2)=? TOTAL=340.00 ITEM(3)=? TOTAL=515.00 ITEM(7)=? TOTAL=2,615.00</pre>

#### **118 9: Running Total and Statistics**

EXIT CALC	2,615.00	Displays CALC menu.
MEAN	MEAN=435.83	Calculates mean.
MEDN	MEDIAN=395.00	Calculates median.
STDEV	STDEV=231.55	Calculates standard deviation.
MORE		Displays rest of CALC menu.
MIN	MIN=175.00	Finds smallest number.

## **Calculations with Two Variables (FRCST)**

The FRCST menu does the following two-variable calculations using two SUM lists:

- Fits *x* and *y*-data to a linear, logarithmic, exponential, or power curve.
- Forecasts estimated values based on that curve.
- Finds the weighted mean and grouped standard deviation.
- Shows you the summation statistics ( $\Sigma x$ ,  $\Sigma x^2$ ,  $\Sigma y$ ,  $\Sigma y^2$ ,  $\Sigma xy$ , etc.).



After pressing **FRCST**, you must specify two previously created lists—one for the *x*-variable and one for the *y*-variable. The two lists must have the same number of items.

Menu Label	Description	
list name for x-variable list name for y-variable	These specify the two lists of data to be com- pared. Also used for estimations: store $x$ and estimate $y$ , or vice-versa. <b>*CURR</b> is the menu la- bel for an unnamed current list.	
CORR *	Calculates the <i>correlation coefficient</i> , a number between $-1$ and $+1$ that measures how closely the <i>x</i> , <i>y</i> data points match the calculated curve.	
M *	Calculates <i>M</i> . For the linear model, this is the slope.	
в .	Calculates <i>B</i> . For the linear model, this is the <i>y</i> -intercept.	
MODL	Displays a choice of the four curve-fitting models: LIN , LOG , EXP , and PWR .	
W.MN	Calculates the weighted mean of the $x$ -values using the weights in the $y$ -list.	
C.SD	Calculates the standard deviation of a set of x- values grouped by frequencies specified in the y- list.	
SIZE	The number of items in either list.	
counter the construction approximation	MORE 🕇	
ΣX	Sum of items in x-list.	
ΣΥ	Sum of items in y-list.	
<b>XX2</b>	Sum of squares of items in x-list.	
ΣΥ2	Sum of squares of items in y-list.	
ΣΧΥ	Sum of products of items in x- and y-lists.	
* For the non-linear models, the calculation uses the transformed data values.		

#### Table 9-3. FRCST Menu Labels

#### **Curve Fitting and Forecasting**

Curve fitting is a statistical method for finding a relationship between two variables, *x* and *y*. Based on this relationship, you can *estimate* new values of *y* based on a given *x*-value, and vice-versa. Each SUM list holds the numbers (data values) for one variable. You can select one of four curve-fitting *models*:\*



\* The exponential, logarithmic, and power models are calculated using transformations that allow the data to be fitted by standard linear regression. The equations for these transformations appear in appendix B. The logarithmic model requires positive *x*-values; the exponential model requires positive *y*-values; and the power curve requires positive *x*- and *y*-values.

#### 122 9: Running Total and Statistics

#### To do curve fitting and forecasting:

- 1. Enter the data into two SUM lists: one for the *x*-values and one for the *y*-values. Make sure each list has the same number of items so that the items are in matched pairs.
- 2. From the SUM menu, press CALC MORE FRCST to display a menu of SUM-list names. The current list is labeled **\*CURR** unless named otherwise.
- **3.** Press a menu key to select a list of *x*-values (*independent variable*).
- **4.** Select a list of *y*-values (*dependent variable*).
- **5.** Now you see the FRCST menu. Whichever curve-fitting model was used last is named in the display. If you want to select a different model, press **MORE MODL**, and then the menu key for the model.



- 6. To calculate the curve-fitting results, press CORR , M , and B .
- 7. To forecast (estimate) a value:
  - **1.** Key in the known value and press the menu key for that variable.
  - **2.** Press the menu key for the variable whose value you want to forecast.

**Example: Curve Fitting.** BJ's Dahlia Garden 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 (x-values, MINUTES)	Dollar Saies (y-values, SALES)
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

BJ's wants to determine whether there is a linear relationship between the amount of radio advertising and the weekly sales. If a strong relationship exists, BJ's wants to use the relationship to forecast sales. A graph of the data looks like this:



#### 124 9: Running Total and Statistics

Keys:	Display:	Description:
SUM		Displays current SUM list and SUM menu keys.
CLEAR DATA	ITEM(1)=?	Clears current list.
2 INPUT 1 INPUT 3 INPUT 5 INPUT 5 INPUT 4 INPUT	ITEM(7)=? Total=20.00	Stores minutes of ad- vertising (x-values) into a SUM list.
EXIT NAME	TYPE NAME:CINPUT]	
MINUTES INPUT	ITEM(7)=?	Names this list. (See page 27 to use the AL- PHA menu.)
NI	where the second list	

Now enter and name the second list.

GET		Gets a new, empty list.
*NEW	ITEM(1)=?	
1400 INPUT 920 INPUT 1100 INPUT 2265 INPUT 2890 INPUT 2200 INPUT	ITEM(7)=? TOTAL=10,775.00	Stores weekly sales (y- values) into a second SUM list.
EXIT NAME	TYPE NAME:CINPUT]	
SALES INPUT	ITEM(7)=?	Names y-list.
CALC MORE FRCST	SELECT X VARIABLE	Identifies the lists for curve-fitting.

MINU		Selects MINUTES as x-
SALES	SELECT Y VARIABLE LINEAR*	list, <i>SALES</i> as <i>y</i> -list, indicates current curve- fitting model, and
		displays FRCST menu.
CORR	CORR=0.90	Correlation coefficient for linear model.

The correlation coefficient calculated above is acceptable to BJ's. Using the linear model, estimate what the level of sales would be if the business purchased 7 minutes of advertising time per week.

7 міни	MINUTES=7.00	Stores 7 in variable <i>MINUTES</i> .
SALES	SALES=3,357.38	Forecasts the sales result- ing from 7 minutes of radio advertising.

How many minutes of advertising should BJ's buy if it wants to attain sales of \$3,000?

3000 SALES		The business should buy
MINU	MINUTES=6.16	about 6 minutes of ad- vertising for sales of \$3.000. <sup>†</sup>
		40)000.

#### Weighted Mean and Grouped Standard Deviation

Data in one list (x) can be weighted or grouped (by frequency) by data in another list (y). To find the mean of weighted data and the standard deviation of grouped data:

**1.** Enter the data values—the *x*-variable—into a SUM list.

<sup>\*</sup> If the model named here is not the one you want to use, press MORE MODL and select the one you want.

<sup>&</sup>lt;sup>†</sup> This result is not the same as it would be if *SALES* were the independent (x) variable, and *MINUTES* were the dependent (y) variable.

- **2.** Enter the corresponding weights or frequencies—the *y*-variables—into another list. (To calculate *G.SD*, the *y*-values should be integers.)
- **3.** From the SUM menu, press CALC MORE FRCST to display a menu of SUM-list names. The current list is **\*CURR** unless named otherwise.
- **4.** Press the menu key for the list of *x*-values.
- **5.** Now select the list with the weights (or frequencies) (*y*).
- 6. To calculate the weighted mean, press MORE W.MN .
- 7. To calculate the grouped standard deviation, press G.SD .

**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?

Create two SUM lists. The first, called RENT, should contain the numbers 200, 205, 210, and 216, in that order. The second can be unnamed and should contain the numbers 54, 32, 88, and 92, in that order.

Keys:	Display:	Description:
SUM		
CLEAR DATA		Clears current list or gets
YES		a new one.
or		
GET		
*NEW	ITEM(1)=?	
200 INPUT		Stores rents into a list.
205 INPUT		
210 INPUT		
216 INPUT	ITEM(5)=?	
	TOTAL=831.00	

EXIT NAME RENT INPUT	ITEM(5)=?	Names this list RENT. (See page 27 to use the ALPHA menu.)
GET *NEW	ITEM(1)=?	Gets a new, empty list.
54 [INPUT] 32 [INPUT] 88 [INPUT]		Stores frequencies into second list.
92 INPUT	ITEM(5)=?	
	TOTAL=266.00	
EXIT CALC MORE		Displays names of all SUM lists.
FRCST	SELECT X VARIABLE	
RENT	SELECT Y VARIABLE	Specifies <i>RENT</i> as the <i>x</i> -list.
*CURR	LINEAR	Specifies the current, un- named list as the <i>y</i> -list and then displays the FRCST menu. (Ignore model type.)
MORE W.MN	209.44	Average monthly rent.
G.SD	5.97	Standard deviation of the rents.

#### **Summation Statistics**

The summation values are of interest if you want to perform other statistical calculations besides those provided by the calculator. To find  $\Sigma x$ ,  $\Sigma x^2$ ,  $\Sigma y$ ,  $\Sigma y^2$ ,  $\Sigma(xy)$ , and *n*, the number of elements in either list:

- 1. Display the FRCST menu and select the *x* and *y*-lists as explained in steps 1–4 of the instructions on page 123. To find the summation statistics for just one list of data, specify the same list for both *x* and *y*.
- 2. To see n, press MORE SIZE .
- **3.** Press MORE again to display the summation menu, and press the menu label for the value you want.

#### **Doing Other Calculations with SUM Data**

If you would like to do other statistical calculations with SUM data besides those in the CALC menu, you can do so by writing your own Solver equation. There are Solver functions that can access data stored in SUM lists, and there is a summation function that can combine all or part of the values stored in specific lists.

Refer to "Accessing CFLO and SUM Lists from the Solver" in chapter 11.

# 10

## Time, Appointments, and Date Arithmetic

The calculator contains a clock and calendar in the TIME menu. You can select a 12-hour or 24-hour clock, and a month-day-year or day-month-year calendar. You can:

- Record 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, the 365-day, or the actual calendar.

## **Viewing the Time and Date**

To view the time and date, press **TIME** in the MAIN menu.

If you overwrite the time and date, you can restore them to the display by pressing  $\Box LR$ .

## The TIME Menu



#### Table 10-1. The TIME Menu Labels

Menu Label	Description
CALC	Displays the CALC menu, for calculating the day of the week and other date arithmetic.
APPT	Displays the APPT menu for setting and viewing appointments.
ADJST	Displays the ADJST menu for adjusting the clock setting.
SET	Displays the SET menu for setting the time and date, and for selecting the time and date formats.

## Setting the Time and Date (SET)

#### Table 10-2. The SET Menu Labels

Menu Label	Description	
DATE	Sets the date to the displayed number ( <i>MM.DDYYYY</i> or <i>DD.MMYYYY</i> ).	
TIME	Sets the time to the displayed number (HH.MMSS).	
A/PM	Switches between AM and PM (12-hour clock).	
M/D	Switches between month/day/year and day.month.year formats.	
12/24	Switches between 12-hour and 24-hour clock formats.	
HELP	Displays the formats for entering the clock's date and time.	

#### To set the time:

- **1.** Press TIME SET to display the SET menu.
- **2.** Key in the correct time in the current format (A or P indicates the 12-hour clock). For example, for 9:08:30 p.m. enter 9.0830 in a 12-hour clock or 21.0830 in a 24-hour clock.
- **3.** Press **TIME** to set the new time.
- **4.** For 12-hour format: press **R/PM** to switch between AM and PM.

#### To set the date:

- Key in the correct date in the current format. For example, for April 3, 1987 enter 4.031987 in month/day/year format or 3.041987 in day.month.year format.
- 2. Press date .

**Example: Setting the Date and Time.** Set the date and time to April 1, 1988, 4:07 p.m.

Keys:	Display:	Description:
SET		Displays SET menu.
4.011988 Date	FRI 04/01/88 <i>time</i>	Sets date.
4.07 TIME A/PM	FRI 04/01/88 04:07:XX P	Sets time. Press R/PM if necessary.

#### **Changing the Time and Date Formats (SET)**

Use the SET menu to change the time and date formats. To switch between the 12- and 24-hour clocks, press 12/24. To switch between the month/day/year and day.month.year calendars, press M/D.

#### **Adjusting the Clock Setting (ADJST)**

The ADJST menu adjusts the time setting forward or backward in increments of hours, minutes, or seconds.

- 1. Press TIME ADJST .
- 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 (APPT)**

You can record up to ten appointments, each with an alarm. An appointment can contain a message. You can also create *repeating appointments*—appointments that recur at regular intervals.



#### Viewing or Setting an Appointment (APT1-APT10)

#### Table 10-3. Menu Labels for Setting Appointments

Menu Label	Description
DATE	Sets the appointment date.
TIME	Sets the appointment time, <i>and</i> automatically enters the current date (if the existing appointment date was in the past).
A/PM	Sets AM or PM for 12-hour clock.
MSG	Displays the ALPHA menu and any existing message.
RPT	Displays the existing repeat interval and the menu for changing the repeat interval.
HELP	Displays the format for entering the date and time.

#### To set an appointment or view its current setting:

**1.** Press **TIME**, then **RPPT**. The display tells you which appointments (numbered 1–10) are *set* and which are *past due* (expired with unacknowledged alarms).

Pressing **MORE** displays the status and menu labels for appointments 6 through 10.

- **2.** Press a menu key— APT1 through APT10. The display shows the current appointment, if any, and the menu labels for setting appointments.
- **3.** Optional: press CLEAR DATA to remove any old information.

Appointment number



**4.** Setting the appointment time: Use 12-hour or 24-hour time, as appropriate. Key in the time as a number in the form *HH.MM*. For example, 2:25 p.m. would be 2.25 (12-hour format) or 14.25 (24-hour format). Press **TIME**. The date is automatically set to the current date if the existing date is in the past or was cleared.

For 12-hour format: press  $\square$  PM to switch between AM and PM.

- 5. Setting the appointment date: Key in the date in the current date format. For example, enter October 4, 1988 as 10.041988 (month/day/year format) or 4.101988 (day.month.year format). Press DRTE . If the appointment is within a year from today, you can omit the year.
- **6.** The appointment message (optional): To set, change, or just view a message, press MSG . Type the message (refer to page 27 for using the ALPHA menu). Messages are limited to a maximum of 22 characters. Press INPUT when done. (Press EXIT to negate any changes and retain the original message.)
- 7. The repeat interval (optional): To set, view, or change a repeat interval, press RPT. Key in an integer and press the appropriate key. For example, 2 DRY causes the appointment to go off at the same time every other day; 90 MIN sets the repeat interval to 1½ hours. NONE sets the appointment to non-repeating. You can specify repeat intervals up to 104 weeks in length (728 days, 17,472 hours, etc.)

8. When done, press EXIT to return to the APPT menu. The appointment you just set will be recorded, such as SET: 1. You can check an appointment by pressing its menu key (such as APT1 ).

**CLR** restores an appointment's time and date to the display if it has been overwritten by other operations.

#### **Acknowledging an Appointment**

To acknowledge the appointment and clear the message, press any key (except ) during the beeping. Appointments not acknowledged within 20 seconds become past due.

When an appointment "comes due," the alarm starts beeping and the alarm annunciator  $(((\bullet)))$  is displayed, even if the calculator was off.\*<sup>†</sup> The message (or, if none, the time and date) is displayed.

#### **Unacknowledged Appointments**

An appointment not acknowledged during its alarm becomes past due. The alarm annunciator remains on.

#### To acknowledge a past-due appointment:

- **1.** Press TIME APPT .
- 2. Press the menu key for the past-due appointment.
- **3.** Press **EXIT** to return to the APPT menu. The acknowledged appointment is no longer listed as past due.

A repeating appointment is deactivated while it is past due and will not go off subsequently until the past-due appointment has been acknowledged.

<sup>\*</sup> If the calculator is in the middle of a complex calculation when an appointment comes due, the alarm annunciator comes on and the calculator beeps once. When the calculation is done, the alarm goes off.

<sup>&</sup>lt;sup>†</sup> The beeping can be suppressed or restricted to appointments. See "Beeper On and Off," page 33.

## **Clearing Appointments**

To cancel an appointment or to get rid of a repeating appointment, you need to *clear* the appointment. Clearing changes the date and time to 00/00/0000, 12:00 AM, and removes the message and the repeat interval.

To clear an appointment, press the menu label for that appointment and press **CLEAR DATA**.

To clear all ten appointments, display the APPT menu (the menu with RPT1 , RPT2 , etc.) and press CLEAR DATA YES .

**Example: Clearing and Setting an Appointment.** Today is Friday, April 15, 1988. You want to set appointment #4 to go off every Tuesday at 2:15 p.m. to remind you of a staff meeting. Assume 12-hour time format and month/day/year date format.

Keys:	Display:	Description:
TIME APPT APT4		Displays setting for ap- pointment #4.
CLEAR DATA	4: 00/00/00 12:00A	Clears appt. #4.
2.15 TIME	4: FRI 04∕15∕88 2:15A	Stores appt. time <i>and</i> supplies current date.
A/PM	4: FRI 04∕15∕88 2:15P	Sets appt. time to PM.
4.19 DATE	4: TUE 04∕19∕88 2:15P	Stores appt. date.
MSG STAFF INPUT	4: TUE 04/19/88 2:15P	Enters message: "staff".
RPT	RPT=NONE	Displays RPT menu.
1 WEEK	RPT=1 WEEK(S) 4: TUE 04/19/88 2:15P	Sets repeat interval.

EXIT

## **Date Arithmetic (CALC)**

The CALC menu performs date arithmetic:

- Determines the day of the week for any date.
- Determines the number of days between dates using one of three calendars—actual, 365-day, or 360-day.
- Adds or subtracts days from a date to determine a new date.

The calendar for date arithmetic runs from October 15, 1582 to December 31, 9999.

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

Menu Label	Description
DATE1 DATE2	Stores or calculates a date. Also displays the day of the week. If you omit the year, the calculator uses the current year.
DAYS	Stores or calculates the number of <i>actual</i> days between <i>DATE1</i> and <i>DATE2</i> , recognizing leap years.
360D	Calculates the number of days between DATE1 and DATE2 using the 360-day calendar (30-day months).
365D	Calculates the number of days between DATE1 and DATE2, using the 365-day calendar, ignoring leap years.
TODAY	A shortcut: recalls the current date, which can then be stored in <i>DATE1</i> or <i>DATE2</i> .

Table 10-4. CALC Menu Labels for Date Arithmetic

The calculator retains the values for the TIME CALC variables *DATE1*, *DATE2*, *DAYS* until you clear them by pressing CLEAR DATA while the CALC menu is displayed.

To see what value is currently stored in a variable, press **RCL** *menu label*.
### 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:

- **1.** Key in the first date (for today's date, use **TODAY** ) and press **DATE1** .
- 2. Key in the second date and press DATE2.
- **3.** Press DRYS , 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, 1986, using both the actual calendar and the 365-day calendar. Assume the date format is month/day/year.

Keys:	Display:	Description:
TIME		Displays CALC menu.
4.201949 DATE1	DATE1= 04/20/1949 WED	Stores Apr. 20, 1949 as first date and displays its day of the week.
8.021986 DATE2	DATE2 =08/02/1986 SAT	Stores Aug. 2, 1986 as second date.
DAYS	ACTUAL DAYS= 13,618.00	Calculates actual number of intervening days.
365D	365 DAYS=13,609.00	Calculates number of in- tervening days by a 365- day calendar.

### **Calculating Past or Future Dates**

To calculate a date a specified number of days from another date:

- **1.** Key in the known date (for today's date, use **TODRY** ) and press **DRTE1** .
- **2.** Key in the number of days. This number should be negative if the unknown date precedes the known date. Press DAYS.
- 3. Press DATE2 .

This calculation always uses the actual calendar.

**Example: Determining a Future Date.** On February 9, 1988, 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		Displays CALC menu.
2.091988 DATE1	DATE1= 02/09/1988 TUE	Stores Feb. 9, 1988.
120 DAYS	ACTUAL DAYS=120.00	Stores number of days into the future.
DATE2	DATE2= 06/08/1988 WED	Calculates expiration date (DATE2).

# 11

# **The Equation Solver**

The Equation Solver (the SOLVE menu) stores equations that you enter and creates menus for them. You can then use those menus to do calculations.

The Solver can store many equations—the number and length of equations is limited only by the amount of memory available. The equations are stored in a *list*.



# An Example Using the Solver: Sales Forecasts

Suppose part of your job includes making sales forecasts, and that these forecasts are revised based on new information. For instance,

- A change in the price of the product will affect sales by a forecasted percentage, A%.
- A change in sales-force training will affect sales by a forecasted percentage, *B*%.
- A competitor's new product will affect sales by a forecasted percentage, C%.

Regardless of how you do this calculation (even if you do it longhand), you are using an equation:

```
Next Forecast = Old Forecast + Change in Old Forecast
= Old Forecast + (Projected Percentage Changes
× Old Forecast)
```

or:

$$NEXT = OLD + ((A\% + B\% + C\%) \div 100 \times OLD)$$

Using the SOLVE and ALPHAbetic menus, you can type in this equation as

```
NEXT=OLD+(A%+B%+C%)÷100×OLD
```

and then automatically create this menu—which contains all the variables' labels—by pressing INPUT CALC :\*

Each menu label represents a *variable*. You can use them to store and calculate values the same way you use other menus and their built-in variables.

**Entering a Solver Equation.** To type this equation, you must use the ALPHA menu. If you are not familiar with the ALPHAbetic menu, refer to "Typing Words and Characters" on page 27.

Keys:	Display:	Description:		
SOLVE		Displays SOLVE menu,		
NEW	TYPE EQUATION;	then ALPHA menu.		
	CINPUTJ			

#### 142 11: The Equation Solver

<sup>\*</sup> Because the Solver uses arithmetic priority (×,  $\div$  before +, –), a second set of parentheses (before A% and after the second *OLD*) is not necessary. See "Order of Calculations," page 153.

NEXT = OLD + ( A % + B % + C %		The equation is too long for the display.
OLD	"D+(A%+B%+C%)	
-	÷100×0LD	
INPUT	NEXT=OLD+ (A%+B%+C%)÷1…	Enters equation into list.
EDIT >>		Controls view of full equation.
>>	…D+(A%+B%+C%)	-
	÷100×0LD	
EXIT	NEXT=OLD+ (A%+B%+C%)÷1…	Displays SOLVE menu.

**Calculating with the Solver.** Suppose last month's forecast for a product was 2,000 units. In the meantime, three market changes have occurred that affect this forecast. A) The price of the product has dropped, causing an expected 20% increase in sales. B) A major salesforce training program started, causing an expected 5% increase in sales. C) A competitor is introducing a new product, causing an expected 15% drop in sales. Calculate the new forecast for next month.

Keys:	Display:	Description:
CALC	VERIFYING EQUATION 0.00	Verifies that equation is valid; creates Solver menu with menu labels for this equation.
2000 OLD	OLD=2,000.00	Stores old forecast.
20 R%	A%=20.00	Stores effect of price drop on sales.
5 в%	B%=5.00	Stores effect of sales- force training on sales.
15 <del>+/_</del> c%	C%=-15.00	Stores effect of competitor's new prod- uct on sales.

NEXT NEXT=2,200.00 Calculates new forecast for next month.

Suppose your boss wants next month's forecast to be 2,300 units. You can't affect A% or C%, but you can affect B% through the sales training program. Determine what B% must be for *NEXT* to equal 2,300 units. All you need to do is re-enter the one value you are changing:

Keys:	Display:	Description:
2300 NEXT	NEXT=2,300.00	
B%	B%=10.00	The training program would need to result in a 10% increase in sales to effect a new forecast of 2,300.

### The SOLVE Menu

If the Solver list is empty, you will see an instruction for entering an equation when you press SOLVE :

# (NEW) FOR NEW EQUATION

If the Solver list is not empty, you will see the *current equation*—the last one entered or selected.

Pressing  $\blacktriangle$ ,  $\bigtriangledown$ ,  $\blacksquare$ , and  $\blacksquare$  moves you through the list.

### Table 11-1. The SOLVE Menu Labels

Menu Label	Description
CALC	Verifies the current equation and creates menu labels for it. This is necessary before doing any calculations.
EDIT	Accesses the ALPHA-Edit menu (page 28) so you can alter the current equation. The arrow keys move long equations across the display.
DELET	Deletes the current equation or just its variables (that is, the space allotted in memory for the variables).
NEW	Allows you to enter a new equation.

While you're working with a specific equation in the Solver, the equation's own menu appears in the display. To retrieve the primary SOLVE menu, press **EXIT**.

# **Entering Equations**

### To make an entry into the Solver list:

- 1. Press SOLVE NEW . (To insert the new entry at the bottom of the list, press .)
- **2.** Use the ALPHA menu to type in characters (see page 27), and use the regular keyboard to type in digits and arithmetic operators (+, =, y<sup>x</sup>, etc.). If you make a mistake, use to backspace or CLR to start over. Or press EXIT to bring up the ALPHA-Edit menu.
- **3.** Press **INPUT** to store the equation.
- **4.** Press **CRLC** to verify that the equation is valid, and to create its menu labels. You now can proceed with your calculations.

When you press CALC , the calculator displays:

VERIFYING EQUATION ...

while the Solver checks that the equation is mathematically valid. (However, the Solver has no way of checking whether the equation is the right one for *your* problem.) If the equation cannot be solved, the calculator briefly displays:

### INVALID EQUATION

and the cursor will blink at the first character that the Solver could not interpret. (It is possible that your mistake is somewhere else, but this is a good place to start looking, since this is where the Solver got stuck.) The ALPHA-Edit menu appears so you can make changes. Check to be sure you've made no typing mistakes, and that you've followed the rules for writing equations given on page 154 under "What Can Appear in an Equation."

An entry that is not an equation will be stored when you press **INPUT**, but it cannot be verified when you press **CALC**.

# **Calculating Using Solver Menus (CALC)**

If pressing CALC creates a Solver menu for your equation, then the equation is good (that is, mathematically valid).

If the equation contains more than six variables, the Solver uses the label **MORE** to switch between sets of menu labels.



Solver menu

To test whether your equation is in fact correct, test it out by entering some values for which you already know the result, and see if the Solver's result is correct.

### To do a calculation using a Solver menu:

- Store values in all but one of the variables (for example, 2000 OLD, etc.). Remember that you can verify stored values by pressing <u>RCL</u> menu label.
- **2.** To start the calculation, press the menu key for the variable you want to calculate.

In most cases, this is all you need to know about how the Solver works. However, certain types of equations are more difficult to solve. If, during the calculation, the display temporarily shows *two* lines of changing numbers, such as

A:1.50000000000 -A:1.13476129834 +

then the Solver is searching for a result for the variable *A*. Read the section, "How the Solver Works," starting on page 166.

**Example: Return on Equity.** The Return on Equity of a business can be defined as:

 $ROE = \frac{Operating income - Interest - Taxes}{Common equity}$ 

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.

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-DEBT×%INT-TAX)÷EQTY

Keys:	Display:	Description:
MAIN		Restores MAIN menu.
SOLVE NEW	TYPE EQUATION; EINPUTJ	Displays ALPHA menu.
ROE = ( ASSET × % ERN - DEBT × % INT - TAX )		Entering the equation.
÷ EQTY	DEBT×%INT-TAX) ÷EQTY	
INPUT	ROE=(ASSET×%ERN -DEBT×…	Stores the equation.
CALC		Verifies the equation and displays the menu labels for <i>ROE</i> , <i>ASSET</i> , <i>%ERN</i> , <i>DEBT</i> , <i>%INT</i> , and (press MORE) <i>TAX</i> and <i>EQTY</i> .
2000 ASSET 10 %ERN 1500 debt 8 %INT More 0 TAX 500 EQTY	ASST=2,000.00 %ERN=10.00 DEBT=1,500.00 %INT=8.00 TAX=0.00 EQTY=500.00	Stores the values for the assets, the percentage earnings on assets, the amount of debt, the percentage interest paid on the debt, the taxes paid, and the common equity.
MORE ROE	ROE=16.00	The return on equity is 16%.

# **Editing an Equation (EDIT)**

If you have an INVALID EQUATION, the cursor stops over the first character that the Solver could not logically interpret.

You can alter the current equation using the ALPHA-Edit menu:

- **1.** Press **EDIT** to access the ALPHA-Edit menu. (See "Editing AL-PHAbetic Text," page 28.) You can use ● (backspace) and CLR (clear), as well.
- **2.** To *insert* letters, press **RLPHR** and the appropriate letters. Press **EXIT** to bring back the editing menu.
- **3.** Press **INPUT** to replace the previous version with the edited version.

Editing an equation clears its variables.

To abort an editing operation without saving any of the changes, press **EXIT**.

# **Naming an Equation**

Naming equations helps you identify them later. The name precedes the equation, separated by a colon. If you don't name an equation initially, you can name it later using **EDIT**.

Type the name just as you type the rest of the equation. The calculator knows that whatever comes before the colon is not part of the equation. The name is for your visual aid only; the calculator cannot recognize it.

Names can be any length and contain any character except + -  $\times$   $\div$  ( ) < > ^ : = space

## Finding an Equation in the Solver List

To display an entry in the Solver list, display the SOLVE menu and move through the list using the  $\blacktriangle$  and  $\bigtriangledown$  keys.  $\blacksquare \land$  moves to <TOP OF LIST> and  $\blacksquare \bigtriangledown$  moves to <BOTTOM OF LIST>.

# **Shared Variables**

If two or more equations contain the same variable, that variable is *shared* among those equations. For example, suppose your Solver list of equations includes these two equations labeled RUG, which figures the cost of a carpet, and TOTAL, which figures the total cost of buying a carpet and installing it:

RUG: P/YD×L×W÷9=COST

TOTAL: COST+HOURS×20.50=CHARGE

*COST* is a shared variable. You can calculate a value for *COST* using the RUG equation, then switch to the TOTAL equation and calculate *CHARGE* after entering *HOURS*. Since the value for *COST* is shared, you do not need to store it again.

No sharing occurs between variables outside the Solver and those within the Solver. For example, this *COST* variable in the Solver is not shared with the *COST* variable in the MU%C and MU%P menus in BUS.

To transfer values between built-in variables and Solver variables, store them into storage registers. Recall them after switching menus. Remember that the value in the calculator line stays there when you switch menus.

# **Clearing Variables**

You can clear the variables in a Solver equation just as you clear variables in other menus: press CLEAR DATA while the menu with those variables is displayed.



Make sure that the *menu for the variables* is in the display. (The equation itself should *not* be in the display. If it is, press **CALC**.) Pressing **CLEAR DATA** now sets *NEXT*, *OLD*, *A*%, *B*%, and *C*% to zero.

Variables are also cleared when their equation is edited.



If the SOLVE menu is displayed (rather than the SOLVE CALC menu), then pressing CLEAR DATA will prompt DELETE ALL VARIABLES?. Press No , otherwise you will lose the variables in all the equations. (See "Delet-

ing All Equations or Variables in the Solver," page 152.)

# **Deleting Variables and Equations**

Each equation in the Solver list uses calculator memory to store 1) itself, and 2) its variables.\*

Deleting a variable is quite different from clearing it:

Clearing a variable sets it to zero; the variable retains its storage location in memory. This does not save memory space.

<sup>\*</sup> An equation that has not been verified ( **CALC** pressed) does not have any variables allocated to it. Therefore, it has no variables to be cleared or deleted.

Deleting a variable erases its value and its storage location. This is a way to save memory space. If a variable is shared, its value is lost to all equations that share it. The memory space for a deleted variable is re-created the next time you use that equation.

### **Deleting One Equation or Its Variables (DELET)**

To delete an equation or its variables:

- **1.** Display the equation.
- **2.** Press **DELET** in the SOLVE menu.
- **3.** To delete the equation, respond YES to both questions:

DELETE THE VARIABLES? DELETE THE EQUATION?

(If the entry has no variables allocated, then only the second question appears.)

**4.** To delete just the variables, respond **NO** to DELETE THE EQUATION?. This preserves the equation.

# **Deleting All Equations or All Variables in the Solver**

To delete *all* the equations in the Solver, or just all the variables in all the equations:

- **1.** Display the SOLVE menu. It doesn't matter which equation is displayed.
- **2.** Press CLEAR DATA. To delete all equations, respond YES to both questions:

DELETE ALL VARIABLES? DELETE ALL EQUATIONS?

**3.** To delete just the variables, respond **NO** to DELETE ALL EQUATIONS?. This preserves all equations.

## **Writing Equations**

An equation in a book looks different from an equation in the Solver. A numerator and denominator might be separated by a bar, such as

$$\frac{a+b+c}{d-e\times f}$$

Since a Solver equation appears all on one line, you must group the numerator and denominator separately by using *parentheses*, such as

$$(A+B+C) \div (D-E\times F)$$

Actually, because the Solver uses the following arithmetic priorities, the equation is also correct without the first set of parentheses:

Order of Calculations. Operations occur from left to right but do:

- **Exponentiation first.** For example,  $A \times B^3 = C$  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 as  $(R \times B)^3 = C$ .
- Multiplication and division before addition and subtraction. For example, A+B+C=12 is interpreted as A + (B/C) = 12. To divide the sum of A + B by C, enter the equation as (A+B)+C=12.

**Parentheses.** Parentheses override the above rules of priority. *When in doubt, use parentheses.* It never hurts to use parentheses—even multiple parentheses. (Do not use brackets or braces.)

For example, earlier (page 142) we used the equation

Next Forecast = Old Forecast + 
$$\left(\frac{(A\% + B\% + C\%) \times \text{Old Forecast}}{100}\right)$$

which was entered into the calculator as

- $\frac{B \times C}{A}$  would be entered as  $(B \times C) \div A$ .
- $\frac{A + B \times C}{D \times E}$  could be entered as  $A + B \times C \div (D \times E)$ .

 $\frac{A + B \times C}{(D + 5) \times E}$  would be entered as  $A + B \times C \div ((D + 5) \times E)$ .

## What Can Appear in an Equation

**Long Equations.** There is no limit on the length of an equation (or the number of variables it has) if there is enough memory to store it. An equation longer than one display line (22 characters) moves to the left and adds an ellipsis (...).

To view a long equation, move the cursor using the arrow keys on the ALPHA-Edit menu. For example:

TOTALCOST=LENGTH×WIDTH×HEIGHT÷12×UNIT×(1+MARKUP% ÷100)

looks like

TOTALCOST=LENGTH×WIDT...

when it is stored. Press **EDIT** -->> to view successive portions of the equation:

...H×HEIGHT÷12×UNIT×(1+...

**Spaces.** You can use as many spaces as you like *between* variables, operators, and numbers.

**Names of Variables.** A variable's name can be up to 10 characters long, but cannot contain the characters  $+ - \times \div$  () < > = : space

The first three to five characters (depending on their widths) become the variable's menu label. Therefore, make sure no two variables in the same equation have the same first three to five characters.

Do not use AND, NOT, OR, XOR, or PI as variable names because they will be interpreted as functions.

**Numbers (Constants).** Do not put commas or other characters in numbers. For instance, type 10000 for ten thousand (*not* \$10,000).

**Parentheses.** Do not use brackets or braces. Parentheses determine order, but do *not* imply multiplication. For example, the equation  $P_{sn} = P_s (1-F)$  would be typed into the Solver as PSN=PS×(1-F). The × sign must be inserted between PS and the parenthesis.

**Functions and Conditional Expressions.** An equation can contain any of the functions and conditional expressions given in the table on pages 157–159. Some of these functions also have *typing aids*.

**Math Operators ("Typing Aids").** All of the math operators are located either on the keyboard ( $\div$ , 1/x, etc.) or in the MATH menu (LN, EXP, etc.). Any of these operators *except* % can be included in an equation. (In the Solver,  $\div$  is just a character.) You can call up the MATH menu from the Solver.

Many of these operators look different in an equation: pressing  $\blacksquare$  (x) produces SQRT( $\cdot$ , for example. You then supply a number or variable followed by a closing parenthesis. The list of Solver functions on pages 157–159 shows the spelling of each function. Note that you supply the number *after* supplying the function.

You can also type these functions letter by letter using the ALPHA menu. However, it is faster to select math operators directly on the keyboard or in the MATH menu. This is called a *typing aid*.

For instance, these two methods of placing 25! (factorial) into an equation are equivalent. Starting after SOLVE NEW :

### 1. Using the ALPHA Menu

Keys:	Display: Description:		
FGHI F ABCDE	F		
A	FA		
C RSTUV	FAC		
Τ	FACT		
() 25 () =	FACT(25)=		
ABCDE	FACT(25)=A	This calculates 25! (factorial).	
2. Using a Typ	ing Aid		
Keys:	Display:	Description:	
MATH		MATH menu labels appear.	
N !	FACT(	The ALPHA menu auto- matically returns after one MATH selection.	
25 )) =	FACT(25)=		
ABCDE	FACT(25)=A	This also calculates 25!, and with fewer keystrokes.	

# **Solver Functions**

Here is a complete list of functions that you can include in Solver equations. The items inside parentheses must be replaced by specific numbers, variables, or algebraic expressions.

In addition, you can use the arithmetic operators  $(+, -, \times, \div, y^x)$ , *but not*  $\Im$ . (In the Solver,  $\stackrel{*}{\sim}$  is just a character, not an operator.)

Function	Description		
ABS(x)	Absolute value of x.		
ALOG(x)	Common (base 10) antilogarithm; 10 <sup>x</sup> .		
CDATE	Current date.		
CTIME	Current time.		
DATE(d1:n)	The date $n$ days after (when $n$ is positive) or before (when $n$ is negative) date $d1$ . The for- mat for $d1$ is set in the TIME/SET menu.		
DDAYS(d1:d2:cal)	Number of days between dates $d1$ and $d2$ . Formats for $d1$ and $d2$ are set in the TIME menu; <i>cal</i> designates the calendar:		
	■ cal = 1 for the actual calendar, which recognizes leap years.		
	<b>c</b> $al = 2$ for the 365-day calendar, which ignores leap years.		
	cal = 3 for the 360-day calendar, which uses 12, 30-day months.		
EXP(x)	Natural antilogarithm; e <sup>*</sup> .		
EXPM1(x)	$e^{x} - 1.$		
FACT(x)	x!; factorial of a positive integer.		
FLOW(CFLO-listname:flow#)	Value of the specified cash flow.		
FP(x)	Fractional part of x.		

Table 11-2. Solver Functions for Equations

Table	11-2.	Solver	<b>Functions</b>	for	Equations	(Continued)
IUNIC		001101			Equations	(ooninaca)

Function	Description
HMS(time)	Converts time in decimal hours to <i>HH.MMSS</i> format.
HRS( <i>time</i> )	Converts time in <i>HH.MMSS</i> format to deci- mal hours.
IDIV(x:y)	Integer part of the quotient of $x/y$ .
IF(cond:expr <sub>1</sub> :expr <sub>2</sub> )	Conditional expression: if <i>cond</i> is true, use $expr_1$ ; if <i>cond</i> is false, use $expr_2$ . See page 161.
INT(x)	Greatest integer less than or equal to x.
INV(x)	Inverse of $x$ ; $1/x$ .
IP(x)	Integer part of x.
ITEM(SUM-listname:item#)	Value of the specified SUM-list item.
LN(x)	Natural (base e) log of x.
LNP1(x)	$\ln (1 + x)$
LOG(x)	Common (base 10) log of x.
MAX(x:y)	Compares x and y, and returns the larger of the two.
MIN(x:y)	Compares $x$ and $y$ , and returns the smaller of the two.
MOD(x:y)	Remainder of the division $x/y$ . MOD $(x,y) = x$ - $y \times INT(x/y)$
PI	$\pi$ ; 3.14159265359 (12 digits).
RND(x:y)	Rounds x to y decimal places if $0 \le y \le 11$ , or rounds x to y significant digits if $-12 \le y$ $\le -1$ . y must be an integer.
S(variable name)	Used in an IF function to test if <i>solving for</i> the variable named. Used to combine related equations into one Solver menu. See page 165.
SGN(x)	Sign of x (+1 if $x > 0$ , 0 if $x = 0$ , -1 if $x < 0$ .

### Table 11-2. Solver Functions for Equations (Continued)

Function	Description
$\Sigma(ctr:c_1:c_2:s:expr)$	Summation of the algebraic expression <i>expr</i> for values of the counter <i>ctr</i> , stepping from $c_1$ to $c_2$ at increments of <i>s</i> . See page 163.
SIZEC(CFLO-listname)	The number of the last flow in specified CFLO list.
SIZES(SUM-listname)	The number of items in specified SUM list.
SPFV(i%:n)	Future value of a single \$1.00 payment; equivalent to $(1 + i\% \div 100)^n$ . <i>n</i> is the num- ber of compounding periods. <i>i</i> % is the interest rate per compounding period, ex- pressed as a percentage.
SPPV(i%:n)	Present value of a single \$1.00 payment; equivalent to $1 \div \text{SPFV}(i\%:n)$ . <i>n</i> is the num- ber of compounding periods. <i>i</i> % is the interest rate per compounding period, ex- pressed as a percentage.
SQ(x)	Square of $x$ ; $x^2$ .
SQRT(x)	Square root of $x$ ; $\sqrt{x}$ .
#T(CFLO-listname:flow#)	The number of times that specified cash flow occurs.
TRN(x:y)	Truncates x to y decimal places if $0 \le y \le 11$ , or truncates x to y significant digits if $-12 \le y \le -1$ . y must be an integer.
USFV( <i>i%:n</i> )	Future value of a uniform series of \$1.00 payments; equivalent to $(SPFV(i\%:n) - 1) \div (i\% \div 100)$ . <i>n</i> is number of payments. <i>i</i> % is periodic interest rate, expressed as a percentage.
USPV(i%:n)	Present value of a uniform series of \$1.00 payments; equivalent to USFV( $i\%$ : $n$ ) ÷ SPFV( $i\%$ : $n$ ). $n$ is number of payments. $i\%$ is periodic interest rate, expressed as a percentage.

**Example Using a Solver Function (USPV): Calculations for a Loan with an Odd First Period.** Suppose an auto purchase is financed with a \$6,000 loan at 13.5% annual interest. There are 36 monthly payments starting in one month and five days. What is the payment amount?

Use the following formula when the time until the first payment is more than one month but less than two months. Interest for this odd (non-integer) period is calculated by multiplying the monthly interest by the number of days and dividing by 30.

The formula for this loan is:

$$PV\left(1 + \frac{ANNI}{1200} \times \frac{DAYS}{30}\right) + PMT\left(\frac{1 - \left(1 + \frac{ANNI}{1200}\right)^{-N}}{\frac{ANNI}{1200}}\right) = 0$$

where:

ANNI = the annual percentage interest rate.

N = the number of payment periods.

DAYS = the number of leftover, odd days (an integer from 0 through 30).

PV = the amount of the loan.

PMT = the monthly payment.

The formula can be rearranged and simplified using USPV, the Solver function for returning the present value of a uniform series of payments:

PV×(1+ANNI÷1200×DAYS÷30)+
PMT×USPV(ANNI÷12:N)=0

The keystrokes are:

PV × (1 + ANNI ÷ 1200 × DAYS ÷ 30 )) + PMT × USPV (1 ANNI ÷ 12:N )) = 0

Keys:	Display:	Description:
SOLVE <b>V</b>	<bottom list="" of=""></bottom>	Displays SOLVE menu and bottom of Solver list.
NEW	TYPE EQUATION; CINPUT]	Displays ALPHA menu.
(type in equa- tion as shown above)	MT×USPV(ANNI÷ 12:N)÷0	Remember that the colon is located after OTHER . (Press WXYZ OTHER : .)
(INPUT) CALC	0.00	Enters equation, verifies it, and creates menu.
6000 PV	PV=6,000.00	Stores loan amount in <i>PV</i> .
13.5 ANNI	ANNI=13.50	Stores annual percent in- terest in <i>ANNI</i> .
5 DAYS	DAYS=5.00	Stores number of odd days in <i>DAYS</i> .
36 N	N=36.00	Stores number of pay- ments in <i>N</i> .
РМТ	PMT=-203.99	Calculates monthly <i>PMT</i> of \$203.99.

### **Conditional Expressions with IF**

Equations can include conditional expressions using the function IF. The syntax of the IF function is:

IF (conditional expression ; algebraic expression ; algebraic expression ; then or else

For example, the Solver accepts the equation:

BONUS=IF(SALES>3000:.02×SALES:.01×SALES)

According to this equation, if *SALES* is greater than 3000, then the *BONUS* equals  $.02 \times SALES$ ; otherwise ("or else"), *BONUS* equals  $.01 \times SALES$ .

**Logical Operators.** Four logical operators can be used in conditional expressions: AND, OR, XOR, and NOT.

**Relational Operators.** Six relational operators are available for conditional expressions.



### **Examples of Conditional Equations.**

■ B = IF (A>7 AND A<=15:2×A÷6:3×A+10)+C

Means: If *A* is greater than 7 and is less than or equal to 15, then  $B = 2 \times A \div 6 + C$ . Otherwise,  $B = 3 \times A + 10 + C$ .

Means: If *FIRST* is not equal to 0, then  $VALUE = FIRST + 1 \div FIRST$ . If FIRST = 0, then VALUE = FIRST.

```
■ T = W×IF(A=0 XOR B=0:A+B:A×B)
```

Means: If A or B, but not both, equals 0, then  $T = W \times (A + B)$ . 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: Nested IF Functions.** An IF function can be used as the argument of another IF function. This is called *nesting*. Suppose a corporation uses a rating system to determine salary. Employees are rated on a scale from 1 through 3, and are given the following annual percent raise based on their rating:

Rating	<b>Percent Salary Increase</b>
1	3%
2	6%
3	10%

The Solver equation to calculate an employee's new salary is based on his or her rating and old salary. What would be the new annual salary for an employee with a rating of 2 who currently earns \$27,500 annually?

Press SOLVE NEW , then enter the equation:

To do the calculation:

Keys:	Display:	Description:
INPUT) CALC		Stores, verifies, and cre- ates menu labels for the equation.
27500 OLD	OLD=27,500.00	Stores old salary.
2 R	R=2.00	Stores rating.
NEW	NEW=29,150.00	Calculates new salary.

### The Summation Function $(\Sigma)$

The  $\Sigma$  function does summation calculations in an equation:

 $\Sigma$  (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  $\Sigma$  function returns the final summation.

For example, when the equation:

is solved for *SERIES*, the counter *I* runs from 1 through 6 in steps of one—that is, 1, 2, 3, 4, 5, 6. For each value *I*, the expression  $I \times X^{1}$  is calculated and added to the sum. Thus the stored value of X is used to calculate  $X + 2X^{2} + 3X^{3} + 4X^{4} + 5X^{5} + 6X^{6}$ .

The following equation uses a variable as the ending value, 0 as the beginning value, and a step size of 2.

If 8 is stored in *LAST*, *I* takes on values of 0, 2, 4, 6, and 8. Then the stored value of X will calculate  $2X^2 + 4X^4 + 6X^6 + 8X^8$ .

### Accessing CFLO and SUM Lists from the Solver

You can use a Solver equation to perform calculations other than those in the CFLO and SUM menus using data stored in CFLO and SUM lists. The following Solver functions gain access to these lists.

- SIZEC(CFLO-listname) returns the number of the last flow in the specified CFLO list. For example, if the last flow in the list INV were FLOW(6)=5,000.00, then SIZE(INV) would equal 6.00.
- FLOW(CFLO-listname: flow number) returns the value of the specified flow.
- #T(CFLO-listname : flow number) returns the number of times the specified flow occurs.
- SIZES(SUM-listname) returns the number of items in the specified SUM list.

ITEM(SUM-listname: item number) returns the value of the specified item.

**Summation of List Data.** The  $\Sigma$  function can be used to sum calculations done with numbers in lists. For example, the following equation calculates  $\Sigma x_i^2 y_i^2$  for values stored in two SUM lists named XVAR and YVAR, which must have the same number of items:

SX2Y2=∑(I:1:SIZES(XVAR):1:ITEM(XVAR:I)^2× ITEM(YVAR:I)^2)

"Chi-Squared Statistics" in chapter 13 illustrates another use of the  $\Sigma$  function with SUM lists.

### **Creating Menus for Multiple Equations (S Function)**

The S (*solving for*) function is used in conjunction with the IF function to group related equations together and to specify the criteria for choosing *one* of them to solve.

S(variable name)

The advantage over two separate equations is that the single equation gives you a single menu with all possible variables. That way, if you are working with two different but related problems, you can keep the same Solver menu labels in the display all the time—you don't have to switch equations.

For example, consider these two equations for conversions:

KG×2.21=LB and M×3.28=FT

The following, rearranged single equation can do either conversion:

This means: if you are *solving for* either *KG* or *LB*, then use  $KG \times 2.21 - LB = 0$ . Otherwise (that is, if you are solving for *M* or *FT*), use  $M \times 3.28 - FT = 0$ . The two conversion equations are rewritten so that all the variables appear on one side of each equation, and the other side is set equal to zero.

The S function appears as part of the conditional expression of the IF function. You can leave out the " = 0 " and it will be understood that the whole equation is set equal to zero.

**Example: Unit Conversions.** Use the above equation to convert between kilograms and pounds and between meters and feet.

Press SOLVE NEW , then enter the equation:

IF(S(KG) OR S(LB):KG×2.21-LB:M×3.28-FT)

Press INPUT to store it, then CALC to verify it and create its menu:



- Convert 225 pounds to kilograms. Press 225 LB KG . Result is KG=101.81.
- How many feet equal 100 meters? Press 100 M FT . Result is FT=328.00.

Note that you do not have to clear variables between steps 1 and 2. The S function considers only those values in the part of the equation that it is solving.

## **How the Solver Works**

The Solver has two ways of finding an answer. First, it tries to find a *direct* solution by rearranging the equation and then solving for the variable. If the Solver finds a direct solution, the calculator displays the result.

If the Solver is unable to find a direct solution, it tries to find the answer indirectly by *iteration*. It estimates a set of answers, sees how close they are to a solution, and then makes another set of estimates. The calculator displays the Solver's current estimates as the Solver searches for an answer. You should keep in mind that *there might be more than one solution to an equation*, and that it might be necessary for you to enter guesses 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 can stop this iterative process, enter your own guesses, and restart the search. (See "Halting and Restarting the Iterative Search" and "Entering Guesses," below.)

The process of finding a solution iteratively is very complex. There are four possible outcomes. Refer to "Solver Calculations" in appendix B for additional descriptions of these outcomes.

- Case 1: The calculator displays a result. It is very likely that this is a solution to the equation. To check how good this result is, you can repeat the calculation by pressing the menu key for the variable you solved for. If the two sides of the equation have not been calculated to be exactly equal, the calculator displays a message with the values for the left and right sides of the equation. Read "Solver Calculations" in appendix B for an explanation of the meaning of this display.
- Case 3: The calculator displays BAD GUESSES: PRESS ECLRJ TO WIEW. The Solver cannot begin the search with the current guesses. Press 
   or CLR to view the starting guesses. To supply new guesses, see "Entering Guesses," below.
- Case 4: The calculator displays SOLUTION NOT FOUND. Check to see if your equation and stored values are correct. If the equation is correct, you might be able to find a solution by entering very good guesses.

### Halting and Restarting the Iterative Search

When the Solver is iteratively searching for a solution (in other words, when the Solver is displaying sets of estimates), you can halt the calculation by pressing any key except . The calculator displays the message INTERRUPTED. To see the best estimate the Solver has found so far, press CLR or . 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 may lead the Solver to a solution in a specified range. The closer your guesses are to the desired solution, 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. If you enter one guess, the Solver generates a second guess.
- After you've halted the iterative search.
- After the Solver has returned an answer, and you wish to begin searching for another answer.

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 uses those two guesses to start searching for a solution. 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 enters 4.5 as a guess for a Solver variable named A and starts the calculation.

To enter two guesses, key in the first guess and press the menu key. Then key in the second guess and press the menu key twice. For example,  $0 \quad R \quad 100 \quad R \quad R \quad causes the Solver to search for$ *A*using 0 and 100.

**Example: Using Guesses to Find a Solution Iteratively.** One equation for calculating the profit from a manufacturing operation is:

Profit = (Price × Quantity) – (Variable costs × Quantity) – 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.)

Press SOLVE NEW , then enter the equation:

Keys:	Display:	Description:
(INPUT) CALC		Stores, verifies, and cre- ates labels for the equation.
6000 PRICE	PRICE=6,000.00	Stores price.
4100 VARCO 112000	VARCO=4,100.00	Stores variable cost, fixed cost, and profit.
FIXC0 130000	FIXCO=112,000	
PROFI	PROFIT=130,000,00	

PROFIT=PRICE×QTY-VARCOST×QTY-FIXCOST

The following steps enter guesses for QTY. If the Solver must search iteratively to solve for QTY, it will begin by using the estimates 100 and 200.

Keys:	Display:	Description:
100 QTY	QTY=100.00	The first guess for QTY.
200 QTY	QTY=200.00	The second guess for <i>QTY</i> .
QTY	QTY:200.0000000000 QTY:100.000000000+	Solves for <i>QTY</i> iteratively.
	QTY=127.37	

# 12

# Printing

The calculator can print information using the HP 82240A 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.\*

ort		
	HEWLETT PACKARD	
	17B	BUSINESS

The print annunciator ( ) appears in the display 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.

<sup>\*</sup> Since the HP-17B cannot send control characters to the printer, portions of the printer's manual pertaining to control codes and graphics characters do not apply.

To preserve battery power, the calculator will not transmit data to the printer when the low-power annunciator ( ) is on. If a low-power condition occurs after you've started a printing operation, printing stops and the calculator displays the message BATT TOO LOW TO PRINT.

# **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.
- **2.** Press **PRNT** to change and display the new mode. If necessary, press **PRNT** again to set the desired mode:
  - PRINTER: AC ADAPTER
  - PRINTER: NO AC ADAPTER
- **3.** Press EXIT.

For long printing operations, printing will be faster using the printer's ac adapter and the calculator's appropriate printing speed mode. When the printer is powered by batteries alone, be sure to change the mode to PRINTER: NO AC ADAPTER so that the calculator will not transmit data too rapidly.

# Printing the Display (PRT)

To print whatever is in the calculator line, press **PRT**. This prints numbers, expressions, single Solver equations, and messages. Menus cannot be printed.

**Printing Other Information** (**PRINTER**)



The PRINTER menu provides the ability to print most of the information you've stored, including the contents of variables, lists,

appointments, the history stack, registers, and the current date and time. You can also transmit descriptive notes to label the output. (To print amortization schedules, see "Printing an Amortization Table," page 71.)

From within any menu you can press **PRINTER** to bring up the PRINTER menu. This table summarizes those printing activities.

Menu Label	Description
LIST	Prints data stored or calculated in the current menu. See "Printing Variables and Lists," below.
STK	Prints the contents of the history stack.
REGS	Prints the contents of registers 0 through 9.
TIME	Prints the current date and time.
MSG	Displays the ALPHA menu for typing a message up to 22 characters long. See page 175.
TRACE	Switches between Trace On and Trace Off modes. See "Trace Printing," page 176.

Table 12-1. The PRINTER Menu Labels

Upon completion, all of these functions except **TRACE** return the previous menu to the display.

### Printing Variables, Lists, and Appointments (LIST)

You can list specific sets of information stored in menus by pressing **PRINTER** LIST while the relevant menu labels are displayed.

**Printing the Values Stored in Variables.** You can print a listing giving the values of all variables whose menu labels are displayed.\* For example, if the calculator is in the FIN TVM menu, it displays the labels N IXYR PV PMT FV OTHER.

Pressing **PRINTER** LIST now produces a print-out like this:

N=	360.00
I%YR=	12.50
PV=	65,000.00
PMT=	-693.00
FV=	0.00
P∕YR=	12.00
END MODE	

**Printing Number Lists.** To print out the contents of a particular SUM or CFLO list, that list must be the *current* list. Pressing **PRINTER** LIST while a SUM list named SALES is the current list produces labeled output like this:

NAME: SALES	Z
ITEM#	VALUE
1 2 3 4 Total=	1,400.00 920.00 1,100.00 2,265.00 5,685.00

\* Except IRR%. Instead, press IRR% [PRT] to print the value for IRR%.

#### 174 12: Printing
**Printing Solver Equations.** To print one or all Solver equations, display the main SOLVE menu (press SOLVE ).

- To print just the current equation, press [PRT].
- To print out 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 . This produces a listing like this for each appointment:

1: SAT 01/23/88 10:00A DEMO FOR SMITH RPT=NONE

**Menus Not Associated with Stored Data.** Remember that many menu labels do not represent data, but rather activities, such as **FIN**, **BUS**, **DELET**, and **SET**. They contain no information for printing. The calculator beeps if there is nothing to print when you press **PRINTER** LIST.

#### **Printing Descriptive Messages (MSG)**

You can include descriptive messages with your printed output by using msc. For example, suppose you wanted to print a number that represents the balance for September. You could start the output with the label "SEPTEMBER BALANCE".

- 1. Press PRINTER, then MSG. This brings up the ALPHA menu.
- 2. Type (and edit) the label or message.
- **3.** Press **INPUT** to print out the label or message.

Now print out the number itself (if it's in the calculator line, press [PRT]).

## **Trace Printing (TRACE)**

Trace printing produces a record of all the keys you've pressed and of calculated results. When tracing is *off*, use **PRT** and **PRINTER** to print what you want. When tracing is on, the calculator uses more power and operates more slowly.

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*.

 $\frac{1}{12} \times 4,800 + 125$ 

Press PRINTER TRACE to set PRINT MODE: TRACE ON. If you see PRINT MODE: TRACE OFF, press TRACE again.

Keys:	Print-out:	
EXIT		EXIT
FIN		FIN
TVM		TVM
12 <b>1/x</b>	12.00	1 / X
	0.08	***
x		×
4800 +	4,800.00	+
125 =	125.00	=
	525.00	***
PMT		PMT
PRINTER	PR	INTER
TRACE		TRACE
EXIT		

## How to Interrupt the Printer

Pressing a calculator key during a printing operation will interrupt transmission, but not immediately stop the printing.

To stop the printer immediately, turn it off.

# 13

# **Additional Examples**

#### Loans

#### **Simple Annual Interest**

**Example: Simple Interest at an Annual Rate.** Your good friend needs a loan to start her latest enterprise and has requested that you lend her \$450 for 60 days. You lend her the money at 7% simple annual interest, to be calculated on a 365-day basis. How much interest will she owe you in 60 days, and what is the total amount owed?

The interest is: (7% of \$450) $\times \frac{60 \text{ days}}{365 \text{ days}}$		
Keys:	Display:	Description:
450 🗙 7 %	450.00 ×.07	Annual interest.
× 60 ÷ 365 +	5.18+	Actual interest for 60 days.
450 =	455.18	Adds principal to get to- tal debt.

#### A Solver Equation for Simple Annual Interest:

DEBT=LOAN+LOAN×I%÷100×DAYS÷365

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. For instructions on entering Solver equations, see "Solving Your Own Equations," on page 26.

If you know the dates for the course of the loan, rather than the number of days, use this for a 365-day basis:

DEBT=LOAN+LOAN×I%÷100×DDAYS(DATE1:DATE2:1)÷365

or use this for a 360-day basis:

```
DEBT=LOAN+LOAN×I%÷100×DDAYS(DATE1:DATE2:3)÷360
```

DATE1 = the date the loan commences. DATE2 = the date the loan ends.

#### 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 amount (if any) (FV), and the price paid for the mortgage (new PV).

Remember the cash-flow sign convention: money paid out is negative, money received is positive.

**Example: Discounted Mortgage.** An investor wishes to purchase a \$100,000 mortgage taken out at 9% 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. What is the yield if the purchase price of the mortgage is \$79,000?

**1.** Since the payment amount (*PMT*) is not given, calculate it first. To do this, first assume 20 years' amortization on the original mortgage with no balloon payment (so  $N = 20 \times 12$ , FV = 0, PV = -100,000, and I%YR = 9).

- **2.** Since the balloon amount is not given, calculate it (*FV*) next. Use *PMT* from step 1, but change *N* to 5 years ( $N = 5 \times 12$ ).
- **3.** Finally enter current values for *N* (less number of payment periods already passed, or  $5 \times 12 42$ ) and *PV* (proposed purchase price, \$79,000); then calculate I%YR for the annual yield.

Keys:	Display:	Description:
FIN TVM OTHER		Selects menu; sets 12 payments per year and End mode.
EXIT	12 P/YR END MODE	
20 <mark>–</mark> N	N=240.00	Figures and stores <i>total</i> number of payments for a full 20-year loan with monthly payments.
9 I%YR 100000 (+∕_) PV	PV=-100,000.00	Stores interest rate and amount of original loan. (Money paid out is negative.)
0 FV	FV=0.00	Sets FV to zero.
PMT	PMT=899.73	Calculates monthly pay- ment received.

**Step 1:** Calculate *PMT*. Make sure FV = 0.

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

Keys:	Display:	Description:
5 N	N=60.00	Stores number of pay- ments for 5 years.
FV	FV=88,707.05	Calculates balloon due in 5 years.

**Step 3:** Enter actual, current values for N and PV; then find new I%YR for discounted mortgage with balloon.

Keys:	Display:	Description:
RCL N - 42 N	N=18.00	Stores number of pay- ments remaining in 5- year loan.
79000 + <u>/</u> PV	PV=-79,000	Stores proposed, dis- counted purchase price (new present value).
I%YR	I%YR=20.72	Calculates percent an- nual yield.

#### Annual Percentage Rate for a Loan with Fees

The annual percentage rate, APR, incorporates fees usually charged when a mortgage is issued, which effectively raises the interest rate. The actual amount received (the *PV*) by the borrower is reduced, while the periodic payments remain the same. The APR can be calculated given the term of the mortgage (*N* periods), the annual interest rate (I%YR), the mortgage amount (new *PV*), and the basis of the fee charged (how the fee is calculated).

Remember the cash-flow sign convention: money paid out is negative, money received is positive.

**Example: APR for 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  $11\frac{1}{2}$ % annually with monthly payments, what APR is the borrower paying?

**1.** Since the payment amount is not given, calculate it (*PMT*) first. Use the given mortgage amount (PV = \$60,000) and interest rate ( $I\%YR = 11\frac{1}{2}\%$ ).

**2.** To find the APR (the new I%YR), use the *PMT* calculated in step 1 and adjust the mortgage amount to reflect the points paid (PV = \$60,000 - 2%). All other values remain the same (term is 30 years; no future value).

Keys:	Display:	Description:
FIN TVM OTHER CLEAR DATA		If necessary, sets 12 pay- ments per year and End mode.
EXIT	12 P/YR END MODE	
30 <mark>- N</mark>	N=360.00	Figures and stores num- ber of payments.
11.5 I%YR 60000 PV	PV=60,000.00	Stores interest rate and amount of loan.
0 FV	FV=0.00	No balloon payment, so future value is zero.
PMT	PMT=-594.17	Borrower's monthly payment.
RCL PV - 2 % PV	PV=58,800.00	Stores actual amount of money received by borrower into <i>PV</i> .
I%YR	I%YR=11.76	Equals APR.

**Example: Loan from the Lender's Point of View.** A \$1,000,000, 10-year, 12% (annual interest) *interest-only* loan has an origination fee of 3 points. What is the yield to the lender? Assume that monthly payments of interest are made. (Before figuring the yield, you must calculate the monthly  $PMT = (loan \times 12\%) \div 12$  mos.) When calculating the I%YR, the FV (a balloon payment) is the entire loan amount, or \$1,000,000, while the PV is the loan amount minus the points.

Keys:	Display:	Description:
FIN TVM OTHER CLEAR DATA		If necessary, sets 12 pay- ments per year and End mode.
EXIT	12 P/YR END MODE	
10 N	N=120,00	Stores total number of payments.
1000000 × 12 % ÷	120,000.00÷	Figures annual interest on \$120,000
12 PMT	PMT=10,000.00	and calculates, then stores monthly payment.
1000000 FV	FV=1,000,000.00	Stores entire loan amount as balloon payment.
- 3 % = +/_ PV	PV=-970,000.00	Calculates, then stores amount borrowed (total – points).
IXYR	I%YR=12.53	Calculates APR—the yield to lender.

#### Loan with an Odd (Partial) First Period

The TVM menu deals with financial transactions in which each payment period is the same length. However, situations exist in which the first payment period is not the same length as the remaining periods. This first period is sometimes called an *odd* or *partial first period*. The following Solver equation calculates N, I%, PV, PMT, or FV for transactions involving an odd first period, using simple interest for the odd period. The formula is valid for 0 to 59 days from inception to first payment, and a 30-day month is assumed.\*

#### A Solver Equation for Odd-Period Calculations:

ODD: PV×(I%+100×FP(DAYS+30)+1)=-IF(DAYS<30; (1+I%+100)×PMT:PMT)×USPV(I%:N)-FV×SPPV(I%:N)

(For the < character, press WXYZ OTHER < .)

PV = the loan amount.

I% = the periodic interest rate.

- DAYS = the actual number of days until the first payment is made. PMT = the periodic payment
- PMT = the periodic payment.
- N = the total number of payment periods.
- FV = the balloon payment. A balloon payment occurs at the end of the last (Nth) period and is in addition to any periodic payment.

The following examples assume that you have entered the equation named ODD, above, into the Solver. For instructions on entering Solver equations, see "Solving Your Own Equations," on page 26.

**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?

Select equation ODD in the Solver.

Keys:	Display:	Description:
CALC		Creates menu.
36 N	N=36.00	36 payment periods.
4500 PV	PV=4,500.00	Stores loan amount.

#### 184 13: Additional Examples

<sup>\*</sup> You do not need to specify Begin or End mode. If the number of days until the first payment is less than 30, Begin mode is assumed. If the number of days until the first payment is between 30 and 59, inclusive, End mode is assumed.

15 ÷ 12		Stores <i>periodic</i> , monthly
I%	I%=1.25	interest rate.
46 DAYS	DAYS=46.00	Stores days until first payment.
0 FV	FV=0.00	No balloon payment.
PMT	PMT=-157.03	Calculates payment.

**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?

Select equation ODD.

Keys:	Display:	Description:
CALC		Creates menu.
10000 ру 24 н 400 <del>"/_</del> ]	PV=10,000.00 N=24.00	Stores known values.
рмт 3000 <del>+/_</del>	PMT=-400.00	
FV	FV=-3,000.00	
8 DAYS	DAYS=8.00	
1%	I%=1.64	Calculates <i>periodic</i> (monthly) interest rate.
× 12 =	19.67	Annual interest rate.

#### **Canadian Mortgages**

In Canadian mortgages, the compounding and payment periods are not the same. Interest is compounded semi-annually while payments are made monthly. To use the TVM menu in the HP-17B, you need to calculate a *Canadian mortgage factor* to store as *I*%YR.

- 1. Set End mode and store 12 P/YR .
- 2. Store 0 PMT , 6 N , and 200 PV .
- **3.** Add 200 to the annual interest rate, make the number negative, and store it in **FV**.
- 4. Press IXYR to calculate the Canadian mortgage factor.
- **5.** Continue the problem by supplying the other mortgage values and solving for the unknown item. *Do not change 1%YR from step 4.*

**Example: 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 TVM OTHER CLEAR DATA		Displays TVM menu; sets 12 payments per year with End mode.
EXIT	12 P/YR END MODE	
0 PMT	PMT=0.00	
6 N	N=6.00	
200 PV	PV=200.00	
+ 12 = +/_ FV	FV=-212.00	
I%YR	I%YR=11.71	Calculates <i>I%YR</i> for Canadian mortgage factor.
30 📕 N	N=360.00	Stores other values.
30000 PV	PV=30,000.00	
0 FV	FV=0.00	
PMT	PMT=-301.92	Monthly payment.

#### A Solver Equation for Canadian Mortgages:

CAN: PV=-PMT×USPV(((1+I%YR÷200)^(1÷6)-1)×100:N) -FV×SPPV((((1+I%YR÷200)^(1÷6)-1)×100:N)

(For the ^ operator, press **[y**<sup>\*</sup>.)

PV = loan amount, or present value. PMT = monthly payment amount. I%YR = annual (Canadian) interest rate as a percent. N = total number of payment periods for the life of the loan.FV = remaining balance, or future value.

For instructions on entering Solver equations, see "Solving Your Own Equations," on page 26.

### **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.

Remember the cash-flow sign convention: money paid out is negative, money received is positive.

#### A Solver Equation for Advance Payments:

ADV: PMT=(-PV-FV×(SPPV(I%YR÷12:N)))÷ (USPV(I%YR÷12:N-#ADV)+#ADV)

(For the **#** character, press WXYZ OTHER **#** .)

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.

The following example assumes that you have entered the equation ADV, above, into the Solver. For instructions on entering Solver equations, see "Solving Your Own Equations," on page 26.

**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%?

Select the ADV equation in the Solver.

Keys:	Display:	Description:
CALC		Creates menu.
750 pv 12 n 0 fv 3 #adv 10 i%yr	I%YR=10.00	Stores known values.
PMT	PMT=-64.45	Calculates payment.

# Savings

#### Value of a Fund with Regular Withdrawals

**Example: A Fund with Regular Withdrawals.** What are the balances after 1, 10, and 20 years of a fund that starts at \$750,000, has \$5,000 withdrawn at the beginning of each month, and earns 15% annual interest compounded quarterly?

- **1.** Because the compounding periods and the withdrawal periods are not coincident, you must first convert the nominal interest rate to one in terms of the withdrawal periods. You can do this using the ICNV menu, as explained on page 77, "Compounding Periods Different from Payment Periods."
- **2.** The rest of the calculation is a straightforward TVM problem. Remember that money deposited is paid out and therefore negative; money withdrawn is received and therefore positive.

Keys:	Display:	Description:
FIN ICNV PER	COMPOUNDING P	Displays periodic inter- est-rate conversion menu.
	TIMES/YR	
4 Р	P=4.00	Stores number of com- pounding periods.
15 NOM%	NOM%=15.00	Stores nominal interest rate.
EFF%	EFF%=15.87	Calculates effective inter- est rate.
12 P	P=12.00	Stores number of with- drawal periods.
NOM%	NOM%=14.82	Calculates adjusted nom inal interest rate.

**Step 1:** Find the adjusted nominal interest rate.

#### **Step 2:** Calculate the future values.

Keys:	Display:	Description:
EXIT EXIT		Switches to TVM menu.
٩	14.82	Clears message to show $NOM\%$ value still in calculator line.
STO I%YR	I%YR=14.82	Stores adjusted nominal interest rate in <i>I%YR</i> .
OTHER 12 P/YR BEG EXIT	12 P/YR BEGIN MODE	Sets 12 payments (with- drawals) per year and Begin mode.
750000 +/_ PV	PV=-750,000.00	Stores present (initial) value of fund.
5000 PMT	PMT=5,000.00	Stores withdrawal amount.
12 N	N=12.00	Stores number of with- drawals in 1 year.
FV	FV=803,947.63	Value of fund at end of year 1.
120 N	N=120.00	Stores number of with- drawals over 10 years.
FV	FV=1,892,666.23	Calculates value of fund at end of year 10.
20 N	N=240.00	Stores number of with- drawals after 20 years.
FV	FV=6,875,123.78	Calculates value of fund at end of year 20.

## **Deposits Needed for a Child's College Account**

Suppose you want to start saving now to accommodate a future series of cash outflows. An example of this is saving money for college. 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.

Use a CFLO list to calculate the net uniform series (*NUS*) of the future withdrawals:

- **1.** Store zero for all cash flows except the withdrawals. For those cash flows, store the amounts you will need to withdraw (since this is cash received, these cash flows will be *positive*).
- **2.** Store the periodic interest rate in *I*% and calculate *NUS*. The *NUS* equals the amount of the monthly deposit you will need to make.

You can also calculate the equivalent present value of all the monthly deposits combined by calculating the net present value, *NPV*.

**Example: Savings for College.** Your daughter will be going to college in 12 years and you are starting a fund for her education. 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?

The cash-flow diagram looks like this:



Figure 13-1. Flow of Withdrawals



Figure 13-2. Flow of Deposits

Keys:	Display:	Description:
FIN CFLO		Displays current cash- flow list and CFLO menu keys.
YES OT		Clears current list or gets a new one.
*NEW	FLOW(0)=?	
Step 1: Set up	a CFLO list.	
0 INPUT	FLOW(1)=?	Sets initial cash flow, FLOW(0), to zero.
0 [INPUT]	#TIMES(1)=1	Stores zero in <i>FLOW(1)</i> and prompts for the number of times it occurs.
12 × 12 - 1 INPUT	FLOW(2)=?	Stores 143 (for 11 years, 11 months) in <i>#TIMES(1)</i> for <i>FLOW(1)</i> .
15000 (INPUT)	#TIMES(2)=1	Stores amount of first withdrawal, at end of 12th year.
INPUT	FLOW(3)=?	
0 [INPUT]	#TIMES(3)=1	Stores cash flows of zero
11 INPUT	FLOW(4)=?	for the next 11 months.

15000 [INPUT] [INPUT]	FLOW(5)=?	Stores second with- drawal, for sophomore year.
0 INPUT 11 INPUT	FLOW(6)=?	Stores cash flows of zero for the next 11 months.
15000 INPUT	FLOW(7)=?	Stores third withdrawal, for junior year.
0 INPUT 11 INPUT	FLOW(8)=?	Stores cash flows of zero for the next 11 months.
15000 INPUT	FLOW(9)=?	Stores fourth with- drawal, for senior year.
EXIT CALC	NPV, NUS, NFV NEED I%	Done entering cash flows; gets CALC menu.

Step 2: Calculate NUS for the monthly deposit.

Keys:	Display:	Description:
9 ÷ 12 I%	I%=0.75	Figures the periodic (monthly) interest rate and stores it in $I\%$ .
NUS	NUS=182.30	Amount of monthly de- posit needed to meet planned withdrawals.
NPV	NPV=17,973.48	Calculates the net present value of the monthly deposits, which is the same as the <i>NPV</i> of the four future withdrawals.

### Value of a Tax-Free Account

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. Remember that for calculations with cash flows, money paid out is negative and money received is positive. (Current tax law and your current income will determine whether just interest or also principal are tax-free, and for how long. You can solve for either case.)

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.

The purchasing power of that future value depends on the inflation rate and the duration of the account.

**Example: Tax-Free Account.** Consider opening an IRA account with a dividend rate of 8.175%. 1) If you invest \$2,000 at the beginning of each year for 35 years, how much will you have at retirement? 2) How much will you have paid into the IRA? 3) How much interest will you have earned? 4) If your post-retirement tax rate is 15%, what is the after-tax future value of the account? Assume only the interest will be taxed. (Assume the principal was taxed before deposit.) 5) What is the purchasing power of that amount, in today's dollars, assuming an 8% annual inflation rate?

Keys:	Display:	Description:
FIN TVM OTHER 1 PZYR		Sets 1 payment per year and Begin mode.
BEG EXIT	1 P/YR BEGIN MODE	
35 N	N=35.00	Stores number of pay- ment periods until retirement (1 $\times$ 35).
8.175 I%YR	I%YR=8.18	Stores dividend rate.
0 PV	PV=0.00	Present value of account (before first payment).
2000 +/_ PMT	PMT=-2,000.00	Annual payment (deposit).
FV	FV=387,640.45	Calculates amount in ac- count at retirement.
RCL PMT × RCL N =	-70,000.00	Calculates total amount paid into IRA by retirement.
+ RCL FV =	317,640.45	Calculates interest you will earn.
× 15 % =	47,646.07	Taxes at 15% of interest.
+/_ + RCL FV =	339,994.39	Subtracts taxes from total <i>FV</i> to calculate after-tax <i>FV</i> .
FV	FV=339,994.39	Stores after-tax future value in <i>FV</i> .
8 IXYR O PMT PV	PV=-22,995.36	Calculates present-value purchasing power of the above after-tax <i>FV</i> at 8% inflation rate.

### Value of a Taxable Retirement Account

This problem uses the TVM menu to calculate the future value of a *taxable* retirement account that receives regular, annual payments beginning today (Begin mode). 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: Taxable Retirement Account.** 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. What will be the purchasing power of that amount in today's dollars, assuming 8% annual inflation?

Keys:	Display:	Description:
FIN TVM		Displays TVM menu.
OTHER 1 P/YR BEG EXIT	1 P/YR BEGIN MODE	Sets 1 payment per year and Begin mode.
35 N	N=35.00	Stores years until retirement.
8.175 × () 1 – 28 % ))	8.18×0.72	Calculates interest rate diminished by tax rate.
I%YR	I%YR=5.89	Stores interest rate.
0 PV	PV=0.00	Stores no present value.
3000 <u>+/</u> PMT	PMT=-3,000.00	Stores annual payment.

FV	FV=345,505.61	Calculates future value.
8 IXYR O PMT PV	PV=-23,368.11	Calculates present-value purchasing power of the above <i>FV</i> at 8% inflation.

## **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%. For example, the cash-flow sequence in the following example has three sign changes and hence up to three potential internal rates of return. (This particular example has three positive real answers: 1.86, 14.35, and 29.02% monthly.)

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.

- **1.** In the CFLO menu, calculate the present value of the *negative* cash flows (*NPV*) at the *safe* rate and store the result in register 0. Enter zero for any cash flow that is positive.
- **2.** Calculate the future value of the *positive* cash flows (*NFV*) at the *reinvestment* rate and store the result in register 1. Enter zero for any cash flow that is negative.
- **3.** In the TVM menu, store the total number of periods in N, the *NPV* result in *PV*, and the *NFV* result in *FV*.
- **4.** Press **IXYR** to calculate the periodic interest rate. This is the modified internal rate of return, MIRR.

**Example: Modified IRR.** An investor has an investment opportunity with the following cash flows:

Group (FLOW no.)	No. of Months (#TIMES)	Cash Flow, \$
0	1	-180,000
1	5	100,000
2	5	-100,000
3	9	0
4	1	200,000

Calculate the MIRR using a safe rate of 8% and a reinvestment (risk) rate of 13%.

Keys:	Display:	Description:
FIN CFL0		Displays current cash- flow list.
YES Or		Clears current list or gets a new one.
GET *NEW	FLOW(0)=?	
180000 (+/_) INPUT	FLOW(1)=?	Stores initial cash flow, FLOW(0).
0 [INPUT]	#TIMES(1)=1	Stores <i>FLOW(1)</i> as zero since the flow amount is positive.
5 INPUT	FLOW(2)=?	Stores 5 for #TIMES(1).
100000 +/_ INPUT	#TIMES(2)=1	Stores FLOW(2).
5 (INPUT)	FLOW(3)=?	Stores <i>FLOW</i> (2) 5 times. You can skip <i>FLOW</i> (3) and <i>FLOW</i> (4) because they are equal to zero for this part.

EXIT CALC	NPV, NUS, NFV NEED I%	
8 ÷ 12 1%	I%=0.67	Stores monthly safe in- terest rate.
NPV	NPV=-654,136.81	Calculates <i>NPV</i> of nega- tive cash flows.
STO 0	NPV=-654,136.81	Stores NPV in register 0.
EXIT	FLOW(3)=?	Returns to CFLO menu.
CLEAR DATA YES	FLOW(0)=?	Clears list.
0 [INPUT]	FLOW(1)=?	Stores zero as <i>FLOW(0).</i> (Skip negative flows; store positive flows.)
100000 [INPUT] 5 [INPUT]	FL0W(2)=?	Stores FLOW(1) 5 times.
0 INPUT 5 INPUT	FLOW(3)=?	Stores zero for FLOW(2), 5 times.
0 INPUT 9 INPUT	FLOW(4)=?	Stores zero for <i>FLOW(3)</i> , 9 times.
200000 INPUT	FLOW(5)=?	Stores FLOW(4), 1 time.
EXIT CALC	NPV, NUS, NFV NEED I%	
13 ÷ 12 1%	I%=1.08	Stores monthly reinvest- ment rate.
NFV	NFV=800,582.75	Calculates <i>NFV</i> of positive cash flows.
STO 1	NFV=800,582.75	Stores NFV in register 1.

MAIN FIN TVM OTHER CLEAR DATA	12 P/YR END MODE	Switches to TVM menu; sets 12 periods per year with End mode, if necessary.
20 N	N=20.00	Stores total number of investment periods.
RCL 0 PV	PV=-654,136.81	Recalls present value of negative cash flows and stores in <i>PV</i> .
RCL 1 FV	800,582.75	Recalls future value of positive cash flows and stores in <i>FV</i> .
0 PMT	PMT=0.00	Stores zero in <i>PMT</i> (no payments).
IXYR	I%YR=12.18	Calculates annual MIRR.

## **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.

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 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.

#### A Solver Equation for Insurance Price:

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, on a savings account. 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.

The following example assumes that you have entered the above equation into the Solver. For instructions on entering Solver equations, see "Solving Your Own Equations," on page 27.

**Example: Insurance Policy.** 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; it will grow to \$4,104 by the end of the year. You can earn 6% on a savings account. What is the annual price per \$1,000 protection?

Select the correct equation in the Solver.

Keys:	Display:	Description:		
CALC		Creates menu.		
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 1%	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=6.57	Your protection cost \$6.57 per \$1,000 face (protection) value.

Insurance protection could be purchased for \$3 per \$1,000 face value. Calculate the rate of return on your savings.

Keys:	Display:	Description:
3 INS	INS=3.00	Stores price of alternate insurance.
1%	I%=2.20	Calculates rate of return.

Reference: Joseph M. Belth, Life Insurance—A Consumer's Handbook, Indiana University Press, 1973, p. 234.

# Bonds

**Example: Yield to Maturity and Yield to Call.** On March 16, 1987 you consider the purchase of a \$1,000 bond that was issued on January 1, 1985. It has a 10.5% semiannual coupon using a 30/360 calendar, and matures on January 1, 2015. The bond is callable on January 1, 1990 at 110 (that is, \$1,100). The bond is now selling at 115.174 (that is, \$1,151.74). Determine both the yield to maturity and the yield to call for this bond.

First, calculate the yield to maturity:

Keys:	Display:	Description:
FIN BOND		Displays BOND menu.
TYPE 360		Sets annual bond on 30/360 calendar.
SEMI EXIT	30/360 SEMIANNUAL	
CLEAR DATA	30∕360 SEMIANNUAL	Clears variables; sets <i>CALL</i> to 100.
3.161987 SETT	SETT= 03/16/1987 MON	Stores today as purchase date.
1.012015 MAT	MAT=01/01/2015 THU	Stores maturity date.
10.5 CPN%	CPN%=10.50	Stores coupon rate.
MORE 115.174 PRICE	PRICE=115.17	Stores price. Displays only two decimal places, but stores all three.
YLD%	YLD%=9.00	Calculates yield to maturity.
Second, calculat	e the yield to call:	
Keys:	Display:	Description:
MORE	YLD%=9.00	Returns to first BOND menu.
1.011990 MAT	MAT=01/01/1990 MON	Changes maturity date to the call date.
110 CALL	CALL=110.00	Stores call value.
MORE YLD%	YLD%=7.63	Calculates a yield to call.

## **Discounted Notes**

A note is a written agreement to pay to 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.

**Solver Equations for Discounted Notes:** To find the price given the discount rate:

NOTE: 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=(RV-PRICE)÷PRICE×36000÷ DDAYS(SETT:MAT:1)

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).

The following example assumes that you have entered the NOTE equations into the Solver. For instructions on entering Solver equations, see "Solving Your Own Equations," on page 27.

**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.)

Select the NOTE:PRICE equation in the Solver.

Keys:	Display:	Description:
CALC		Creates menu.
10.141988 SETT 3.171989 MAT 8.7 DISC 100 RV	SETT=10.14 MAT=3.17 DISC=8.70 RV=100.00	Stores known values.
PRICE	PRICE=96.28	Calculates price.
EXIT V CALC	NOTE:YIELD= (RV-PRICE)…	Displays NOTE:YIELD equation, then its menu.
YIELD	YIELD=9.04	Calculates yield.

## **Statistics**

#### **Moving Average**

Moving averages are often useful in predicting trends in data taken over a period of time. In moving-average calculations, a specified number of points is averaged. Each time a new point is acquired, the oldest point is discarded. Thus, the same number of points is used in each calculation.

#### A Solver Equation for Moving Averages:

N = the number of values averaged in each calculation. LAST = the item number of the most recent value to be averaged. name = the name of the SUM list whose data will be averaged. When you create and name the SUM list, make sure its name matches the *name* in the Solver equation.

The following example assumes that you have entered the equation MAVG into the Solver, using VOL for the SUM list's *name*. For instructions on entering Solver equations, see "Solving Your Own Equations," on page 27.

**Example: A Moving Average in Manufacturing.** Calculate a threemonth moving average for the number of units manufactured during the first half of the year. Manufacturing volumes are:

J	anuary	February	March	April	May	June
	4400	5360	2900	3670	4040	3200
Keys:	I	Display:		De	escripti	on:
SUM				Di cu	isplays S irrent lis	SUM menu and st.
YES	ATA			Cl a	ears cui new on	rrent list or gets e.
GET *NEW		ITEM(1)=?				
4400 INPL 5360 INPL 2900 INPL 3670 INPL 4040 INPL				Er	nters da	ta.
3200 INPU	IT .	ITEM(7)=? TOTAL=23,	570.00			
EXIT NA VOL INPU	ME T	ITEM(7)=?		N	ames th	e list VOL.
EXIT SOL (use ▼ an if necessar	.VE d ▲ V)			Di eq na	isplays juation. me is V	the MAVG Make sure OL.

CALC		Displays menu.
3 N	N=3.00	Stores number of points.
3 LAST MAVG	MAVG=4,220.00	Calculates average for months 1, 2, and 3.
4 LAST MAVG	MAVG=3,976.67	Calculates average for months 2, 3, and 4.
5 LAST 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 $(\chi^2)$ Statistics

The  $\chi^2$  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, it tests whether discrepancies between the observed frequencies  $(O_i)$  and the expected frequencies  $(E_i)$  are significant, or whether they might reasonably result from chance. The equation is:

$$\chi^{2} = \sum_{i=1}^{n} \frac{(O_{i} - E_{i})^{2}}{E_{i}}$$

If there is a close agreement between the observed and expected frequencies,  $\chi^2$  will be small. If the agreement is poor,  $\chi^2$  will be large.

<sup>\*</sup> The statistic can be assumed to be  $\chi^2$  distributed with n-1 degrees of freedom if n or some of the  $E_i$  values are large.

#### Solver Equations for $\chi^2$ Calculations:

If the expected value is a constant:

CHI=Z(I:1:SIZES(name1):1:(ITEM(name1:I) -EXP)^2÷EXP)

#### If the expected values vary:

CHI2= $\Sigma$ (I:1:SIZES(name1):1:(ITEM(name1:I) -ITEM(name2:I))^2+ITEM(name2:I))

(To enter the  $\Sigma$  character, press WXYZ OTHER MORE  $\Sigma$  .)

CHI2 = the final  $\chi^2$  value for your data.

name1 = the name of the SUM list that contains the *observed values*. name2 = the name of the SUM list that contains the *expected values*. EXP = the expected value when it is a constant.

When you create and name the SUM list(s), make sure the name(s) match *name1* (and *name2*, if applicable) in the Solver equation.

To solve the equation, press CH12 once or twice (until you see the message CALCULATING...).

The following example assumes that you have entered the CHI equation into the Solver, using OBS for *name1*. For instructions on entering Solver equations, see "Solving Your Own Equations," on page 27.

**Example: Expected Throws of a Die.** 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,  $120 \div 6$ , or 20.)

Number	1	2	3	4	5	6
Frequency Observed	25	17	15	23	24	16

Keystrokes:	Display:	Description:
SUM		Displays SUM menu and current list.
YES		Clears current list or gets a new one.
OF		
*NEW	ITEM(1)=?	
25 INPUT 17 INPUT 15 INPUT 23 INPUT 24 INPUT		Enters observed values.
	ITEM(7)=?	
	TOTAL=120.00	
EXIT NAME OBS INPUT	ITEM(7)=?	Names the list OBS.
EXIT SOLVE (use 🛦 and 🛡 if necessary)		Displays the CHI equa- tion. Make sure <i>name1</i> is OBS.
CALC		Displays menu.
20 EXP	EXP=20.00	Stores expected value.
CHI	CHI=5.00	Calculates $\chi^2$ .

The number of degrees of freedom is (n - 1) = 5. Consult statistical tables to find  $\chi^2$  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.


# Assistance, Batteries, Memory, and Service

# **Obtaining Help in Operating the Calculator**

Hewlett-Packard is committed to supporting users of HP calculators. You can obtain answers to your questions about using the calculator from our Calculator Technical Support department. (Address and phone number are on the inside of the back cover).

We suggest reading "Answers to Common Questions", below, before contacting us. Past experience has shown that many of our customers have similar questions.

# **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 220, which describes the diagnostic self-test.

**Q:** My numbers contain commas as decimal points. How do I restore the periods?

A: Press DISP . .

**Q:** How do I change the number of decimal places the calculator displays?

A: The procedure is described in "Decimal Places" on page 31.

**Q:** How do I clear all or portions of memory?

A: CLR clears the calculator line. CLEAR DATA clears the data lists or variables accessible from the current menu. Erasing the entire contents of memory is covered in "Erasing Continuous Memory" on page 218.

Q: Why am I getting the wrong answer using the TVM menu?

A: Be sure to enter a value for *all five TVM variables*, even if a value is zero (as *FV* is for a loan without a balloon). Clearing the variables before starting (**CLEAR DATA**) accomplishes the same thing. Check the appropriate payment mode (mortgages and loans are typically End mode calculations), and specify the number of payments per year (**P**<YR). Also check that all figures for money paid out are *negative* (the cash-flow sign convention).

**Q:** Can I access the TVM menu functions from the Solver?

**A:** No, but you can do the same functions by copying the appropriate financial formulas into the Solver. The formulas are given starting on page 157.

**Q:** Can I access the data stored in my CFLO and SUM lists from the Solver?

**A:** Yes. See "Accessing CFLO and SUM Lists from the Solver," page 164.

**Q:** How do I indicate multiplication in an equation typed into the Solver?

**A:** Use the multiplication key  $(\mathbf{x})$ . You cannot use the letter **x** in the ALPHA menu.

**Q:** What does an "E" in a number (for example, 2.51E - 13) mean?

**A:** *Exponent* of ten (for example,  $2.51 \times 10^{-13}$ . Refer to "Scientific Notation" on page 44.

**Q:** The calculator has displayed the message INSUFFICIENT MEMORY. What should I do?

**A:** Refer to "Managing Calculator Memory" on page 216 for instructions on how to reclaim memory for your use.

**Q:** The calculator is operating slowly, and the **mass** annunciator is blinking. Why?

A: The calculator is trace 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: Press RCL INPUT +/\_ INPUT.

**Q:** The beeper is not working.

A: Check the beeper mode by pressing **MODES BEEP**. See also page 33.

**Q:** The messages and the menu labels in the display are not in English. How do I restore the English?

A: Models of the HP-17B sold in many countries outside of the United States include a menu to select the language for messages and labels **MODES** INTL ENGL.

# **Power and Batteries**

The calculator is shipped with mercury batteries. A fresh set of three mercury batteries typically provides approximately 7 to 17 months of use. (Alkaline batteries last about half as long.) However, expected battery life depends on how the calculator is used. Transmitting data to the printer requires much more power than other operations.

Use only fresh button-cell batteries. Do not use rechargeable batteries. The following batteries are recommended for use. Not all batteries are available in all countries.

Mercury	Alkaline
Panasonic NR44 or MR44	Panasonic LR44
Kodak KX675	UCAR A76
Duracell MP675 or PX675	Varta V13GA
Toshiba NR44 or MR44	Kodak KA76
Radio Shack NR44 or MR44	
Varta V675HP	

## **Low-Power Indications**

When the low-battery annunciator ( ) comes on, the calculator can continue operating for at least 36 hours. If the calculator is turned off, Continuous Memory will be preserved for at least 16 days. To conserve battery power, printing does not function when the battery annunciator is on. Printing might halt during a printing operation due to a borderline low-battery condition. The calculator can detect that there is insufficient power for printing before the battery annunciator comes on.

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 in order to preserve stored data. The calculator will require fresh batteries before it can be turned back on. When you turn the calculator on after fresh batteries have been installed, the calculator displays MACHINE RESET if your stored data is intact. If data has been lost, the calculator displays MEMORY LOST. In either case, the clock's time might 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 button-cell batteries at hand. Make sure no appointment will come due while the batteries are out.
- 2. Make sure the calculator is *off.* Do not press CLR again until the entire procedure for changing batteries is completed. Changing batteries with the calculator on can erase the contents of Continuous Memory. (If you have set any appointments, make sure they will not come due while the batteries are out.)

**3.** Hold the calculator as shown. To remove the battery-compartment door, press down and outward on the ribbed area until the door slides off.



4. Turn the calculator over and shake the batteries out.



Do not mutilate, puncture, or dispose of batteries in fire. The batteries can burst or explode, releasing hazardous chemicals.

**5.** Insert three new batteries as shown. Orient the batteries as shown on the diagram inside the battery compartment. Be sure the raised and flat ends match the diagram.



**6.** Slide the tab of the battery-compartment door into the slot in the calculator case, as shown.



Now turn the calculator back on. If it does not function, you might have taken too long to change the batteries or inadvertently turned the calculator on while the batteries were out. *Remove the batteries* again and lightly press a coin against both battery contacts in the calculator *for a few seconds*. Put the batteries back in and turn the calculator on. You should see MEMORY LOST.

# **Managing Calculator Memory**

The calculator has approximately 6,750 units (or "bytes") of *user* memory available.\* (This is separate from the *system* memory that stores all the unerasable information with which the calculator is manufactured.) The table below describes the memory requirements of stored user information.

The calculator displays INSUFFICIENT MEMORY if you attempt an operation that uses more memory than is currently available. If you see this message:

 Complete any calculations in the calculator line (press = or CLR). This frees the memory that was being used to store each of the numbers and operators.

<sup>\*</sup> There are 8,000 bytes total in RAM (random access memory): 6,750 bytes plus 1,250 bytes reserved by the system to store your values in built-in variables.

- 2. To further increase the amount of available memory:
  - Rename the named SUM and CFLO lists with shorter names (see page 97), and clear any lists you no longer need (see page 99).
  - Shorten or delete any messages with appointments (see page 135).
  - Delete any Solver variables or equations you no longer need (see page 152).

Type of Information	Amount of Memory Used
CFLO number lists (excluding the list name)	$10^{1/2}$ bytes per list, $+ 9^{1/2}$ bytes per flow entry (flow amount and #TIMES).
SUM number lists (excluding the list name)	16 bytes per list, + 8 bytes per item.
Names of lists	1 byte, + 1 byte per character.
Equations	10 <sup>1</sup> / <sub>2</sub> bytes, + 1 byte per character (spaces are counted as characters), including the name.*
Solver variables	15 bytes per variable, + 1 byte per character in the variable's name.
Calculator line	Numbers: 8 bytes, + 1 byte per character.
	Operators: 3 <sup>1</sup> / <sub>2</sub> bytes.
Appointment messages	41 bytes for the first message stored, $+$ 1 byte per character in each message.

### **Table A-1. Memory Requirements**

The memory requirements of an equation substantially increase while its menu is displayed.

# **Resetting the Calculator**

If the calculator doesn't respond to keystrokes or is behaving unusually, attempt to reset it. Resetting the calculator halts the current calculation, clears the calculator line, and displays the MAIN menu. Continuous Memory is not affected. To reset the calculator, hold down CLR while pressing the third menu key from the left. Repeat if necessary. The calculator displays MACHINE RESET.

The calculator can reset itself if it is dropped or if power is interrupted.

# **Erasing Continuous Memory**

Erasing Continuous Memory erases all user-stored information except the current time and date. Specifically, it:

- Clears the calculator line and history stack.
- Deletes all Solver equations and their variables, and clears all other variables in menus.
- Clears all CFLO and SUM lists and their names.
- Clears all appointments.
- Sets the calculator to certain "start-up" settings—month/day/year date format, 12-hour clock, 2 decimal places, period (.) decimal point, printer tracing off, printer without the ac adapter, and beeper on.

Erasing Continuous Memory does not affect the current time and date.

To erase Continuous Memory, press and hold down CLR, the leftmost menu key, and the rightmost menu key. (Press three keys simultaneously). When the three keys are released, the calculator displays MEMORY LOST.

Continuous Memory can inadvertently be erased if the calculator is dropped or if power is interrupted.

# **Clock Accuracy**

The clock is regulated by a quartz crystal accurate to within three minutes per month under normal conditions. The accuracy of the clock crystal is affected by temperature, physical shock, humidity, and aging. Optimum accuracy is maintained at 25°C (77°F).

### 218 A: Assistance, Batteries, Memory, and Service

# **Environmental Limits**

In order to maintain product reliability, observe the following limits:

- Operating temperature: 0° to 45°C (32° to 113°F).
- Storage temperature: -20° to 65°C (-4° 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 it does, read "If the Calculator Requires Service" on page 222.

#### If the calculator won't turn on:

- **1.** Attempt to reset the calculator (see page 217).
- **2.** If the calculator fails to respond after step 1, replace the batteries (see page 214). *If you have just replaced the batteries*, see page 216.

If these steps do not help, the calculator requires service.

### If the calculator doesn't respond to keystrokes:

- **1.** Attempt to reset the calculator (see page 217).
- **2.** If the calculator still fails to respond, attempt to erase Continuous Memory (see page 218). This will erase all the information you've stored.
- If these steps do not help, 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 you've made a mistake in operating the calculator. Try rereading portions of the manual, and check "Answers to Common Questions" on page 225.
- **3.** Contact the Calculator Technical Support department. The address and phone number are listed on the inside back cover.

# **Confirming Calculator Operation:** 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. The selftest runs continuously, repeating until you halt it.

To run the self-test:

- **1.** Turn the calculator on.
- **2.** If you have the optional infrared printer, turn it on. Certain diagnostic information is printed during the test.
- 3. If possible, return to the MAIN menu (press MAIN).
- **4.** To start the self-test, hold down CLR 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.
- **5.** During the test, the calculator beeps periodically and displays various patterns and characters. Watch for one of two messages that are displayed before the test automatically repeats:
  - If the calculator passes the self-test, the calculator displays 0K-17B-E.
  - If the calculator displays FAIL followed by a five-digit number, the calculator requires service.
- 6. To halt the self-test, hold down CLR while you press the third menu key from the left. The calculator displays MACHINE RESET. If you press any other key instead, the test halts and the calculator displays a FAIL message. This results from an incorrect key being pressed, and does not mean that the calculator requires service.

**7.** If the calculator failed the self-test, repeat steps 4 through 6 to verify the results. If you do not have a printer, write down the messages that are displayed in step 5.

# **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 a equivalent or better model), whether it is under warranty or not. There is a charge for service after the warranty period. Calculators normally are serviced and reshipped within 5 working days of receipt.

# **Obtaining Service**

■ In the United States: Send the calculator to the Calculator 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: (022) 82 81 11

In other countries: Contact your HP sales office or dealer or write to the U.S. Calculator 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 U.S. Calculator 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 Calculator 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.) Be sure to:

- 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. In the United States and some other countries, the serviced calculator will be returned C.O.D. if you do not pay in advance.
- 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 Calculator Service Center (see the inside of the back cover).

# **Regulatory Information**

### **Radio Frequency Interference**

**U.S.A.** The HP-17B 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-17B 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 Ra-dio-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-17B and the HP 82240A 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-17B and the HP 82240A 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.



# **More About Calculations**

# **IRR% Calculations**

The calculator determines *IRR*% for a set of cash flows using mathematical formulas 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, this is called an iterative process.

In most cases, the calculator finds the desired answer, since there is usually only one solution to the calculation. 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 calculator 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.

- **Case 1:** The calculator displays a positive answer. This is the only positive answer. However, one or more negative answers may exist.
- **Case 2:** The calculator finds a negative answer but a single positive solution also exists. It displays:

IRR%>0 EXISTS; KEY
IN GUESS; ESTO1 (IRR%)

To see the negative answer, press . To search for that positive answer, you must input a guess. (Refer to "Storing a Guess for *IRR%*"; below). There might also be additional negative answers.

- **Case 3:** The calculator displays a negative answer and no message. This is the only answer.
- **Case 4:** The calculator displays the message:

MANY/NO SOLUTIONS; KEY IN GUESS; ESTOI (IRR%)

The calculation is very complex. It might involve more than one positive or negative answer, or there may be no solution. To continue the calculation, you must store a guess.

■ Case 5: The calculator displays: NO SOLUTION

There is no answer. This situation might be the result of an error, such as a mistake in keying in the cash flows. A common mistake is to put the wrong sign for a cash flow. A valid cash flow series must have 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 calculator 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%**

To enter a guess, key in an estimate of *IRR*% and then press <u>STO</u> IRR%. You can enter a guess for IRR% at these times:

- Before beginning the calculation. This can reduce the time required to calculate an answer.
- After you've halted the calculation.
- After the calculator has halted the calculation due to any of the above cases. For cases 3 and 5, however, no (other) solutions will be found.

When calculating *IRR*% using a guess, the calculator displays the current estimate of *IRR*% and the calculated value of *NPV* for each iteration. The calculation halts when the calculator finds an answer. However, there may be additional positive or negative answers, or no true solution at all. You can continue searching for other solutions by halting the calculation and entering a different guess.

One way to obtain a good guess for IRR% is to calculate NPV for various interest rates (I%). Since IRR% is the interest rate at which NPV equals zero, the best estimate of IRR% is the interest rate that yields the value for NPV closest to zero.

To find a good estimate for IRR%, key in a guess for IRR% and press 1%. Then, press NPV to calculate NPV for that value. Repeat the calculation of NPV for several values of I%, and look for trends in the results. Choose as your guess for IRR% a value of I% that produces an NPV close to zero.

# **Solver Calculations**

As noted in chapter 11, the Solver uses two methods to find solutions, depending on the complexity of the equation: *direct* and *iterative* (an indirect). To use all the calculating power included in the Solver, it would help 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 (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, suppose you enter the equation:

$$PROFIT = PRICE - COST$$

If you've stored values for *PROFIT* and *PRICE*, pressing **COST** causes the Solver to internally rearrange the equation algebraically to solve for *COST* (*COST* is the unknown):

$$COST = PRICE - PROFIT$$

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 stored. Then the calculator displays: SOLUTION NOT FOUND

For example, if you enter an equation:

$$AREA = L \times W$$

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 zero for *W*, the Solver cannot find an answer because division by zero is not allowed.

The Solver can isolate the unknown variable if the equation meets these conditions:

■ The unknown variable occurs only once in the equation.\*

<sup>\*</sup> Exceptions: (1) Occurrences of the unknown variable as the argument of the S function are ignored. (2) The unknown variable can appear twice within an IF function: once in the *then* clause and once in the *else* clause.

- The only functions in which the unknown variable appears are ALOG, DATE, DDAYS (actual calendar only), EXP, EXPM1, IF (in then and else clauses only), INV, LN, LNP1, LOG, S, SQ, and SQRT.
- The only operators involving the unknown variable are  $+, -, \times, \div$ , and ^ (power). If you are solving for a variable raised to a positive, even power (for example,  $A \land 2 = 4$ ), there may be more than one solution. However, if the Solver can isolate the variable, it will find *one* of the solutions using the positive root. For example, the Solver rearranges  $A \land 2 = 4$  to  $A = \sqrt{4}$  and calculates the answer +2.\*
- The unknown variable does not appear as an exponent.

### **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 iteratively for a solution.<sup>†</sup>

In its iterative search for a solution, the Solver looks for a value that sets the left side of the equation equal to the right side. To do this, the Solver starts with 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 zero for *LEFT* – *RIGHT*, the Solver analyzes the results 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 this search, the calculator displays the two current estimates and the sign of (*LEFT* – *RIGHT*) for each estimate, as shown.

<sup>\*</sup> An equation can be rewritten to cause the Solver to find the negative root. For example, if  $A \land 2 = 4$  is rewritten as  $(-A) \land 2 = 4$ , the Solver rearranges the equation to  $A = -\sqrt{4}$  and calculates the solution -2.

<sup>&</sup>lt;sup>†</sup> The Solver's ability to find a solution iteratively 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  $1 \div (A \land 2 - A) = B$  is rewritten as  $(A \land 2 - A) \times B = 1$ .



Sign of LEFT-RIGHT for each estimate

Since calculators cannot do calculations with infinite precision (the HP-17B uses 12 digits in its calculations), sometimes the Solver will be unable to find an estimate where LEFT - RIGHT is exactly zero. However, the Solver can distinguish between situations where the current estimate *could* be a solution, and situations where no solution is found.

The iterative search for a solution sometimes takes several minutes. (You can halt the search at any time by pressing any key except .) There are four possible outcomes:

**Case 1:** The calculator displays an answer. This is very likely the true solution for the unknown variable.

There are two situations in which the Solver returns a case 1 answer:

- Case 1a: LEFT RIGHT is exactly zero.
- 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.





*LEFT*—*RIGHT* is not exactly 0. *LEFT* and *RIGHT* are relatively close together. The two estimates are "neighbors".

If you want to know whether LEFT - RIGHT is *exactly* zero, press the menu key for the unknown variable. If LEFT - RIGHT is *not* equal to zero, the calculator displays the values of *LEFT* and *RIGHT*.



The equation could have more than one iterative solution. If the answer does not seem reasonable, enter one or two guesses and restart the search.

■ **Case 2:** The calculator displays the values of *LEFT* and *RIGHT*, which are unequal. To see the calculator's result, press ◆ or CLR. If *LEFT* and *RIGHT* are relatively close to one another in value, the result is probably a true solution. Otherwise, the result is probably not a true solution.

If the result seems unreasonable, it could be because the equation has more than one 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.



This information can be helpful:

- 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 "bracket" an ideal solution (a solution where *LEFT RIGHT* equals zero). If *LEFT* and *RIGHT* are relatively close together, the answer is probably a solution.
- Case 2b: If the signs of LEFT RIGHT are opposite, and the two estimates are not neighbors, 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 two estimates have the same sign, the Solver has halted because it could find no estimates that further reduced the magnitude of LEFT RIGHT. 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.







**Case 2b:** *LEFT*-*RIGHT* have opposite signs. The two estimates are far apart.



Case 2c:

*LEFT*-*RIGHT* have the same sign.

**Case 3:** The calculator displays:

BAD GUESSES: PRESS ECLRJ TO VIEW

The Solver is unable to begin its iterative search for a solution using the current initial estimates (guesses). You might find a solution by entering different estimates. The closer you can estimate the answer, the more likely that the Solver will find a solution.

■ Case 4: The calculator displays: SOLUTION NOT FOUND

The Solver is unable to find a solution. Check your equation to make sure you have made no errors in entering it. Also check

the value of each known variable. If your equation and variables are correct, you *might* be able to find a solution by entering very good guesses.

# **Equations Used by Built-in 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) = 
$$\left(1 + \frac{i\%}{100}\right)^{\prime}$$

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.)

$$USFV (i\%:n) = \frac{\left(1 + \frac{i\%}{100}\right)^n - 1}{\frac{i\%}{100}}$$

**Percentage Calculations in Business (BUS)** 

$$%CHANGE = \left(\frac{NEW - OLD}{OLD}\right) \times 100$$
$$%TOTAL = \left(\frac{PART}{TOTAL}\right) \times 100$$

$$MARKUP\%C = \left(\frac{PRICE - COST}{COST}\right) \times 100$$

$$MARKUP\%P = \left(\frac{PRICE - COST}{PRICE}\right) \times 100$$

### 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

 $\Sigma INT$  = 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:

 $INT' = BAL \times i$  (INT' is rounded to the current display setting; INT' = 0 for period 0 in Begin mode)

$$INT = INT' \text{ (with sign of PMT)}$$
$$PRIN = PMT + INT'$$
$$BAL_{new} = BAL_{old} + PRIN$$
$$\Sigma INT_{new} = \Sigma INT_{old} + INT$$
$$\Sigma PRIN_{new} = \Sigma PRIN_{old} + PRIN$$

### **Interest Rate Conversions**

Periodic compounding

$$EFF\% = \left[ \left( 1 + \frac{NOM\%}{100 \times P} \right)^{P} - 1 \right] \times 100$$

Continuous compounding

$$EFF\% = \left(\frac{\frac{NOM\%}{100}}{e} - 1\right) \times 100$$

### **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.

$$N_{j} = \sum_{1 \leq l < j} n_{l} = \text{total number of cash flows prior to group } j$$
$$NPV = CF_{0} + \sum_{j=1}^{k} (CF_{j} \times USPV (i\%:n_{j}) \times SPPV (i\%:N_{j}))$$

When NPV = 0, the solution for *i*% is *IRR*%.

$$NFV = NPV \times SPFV$$
 (i%:N) where  $N = \sum_{j=1}^{\kappa} n_j$   
 $NUS = \frac{NPV}{USPV$  (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 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:

$$PRICE = \left[\frac{CALL}{\left(1 + \frac{Y}{M}\right)^{N-1} + \frac{DSC}{E}}\right]$$

$$+ \left[\sum_{K=1}^{N} \frac{\frac{CPN\%}{M}}{\left(1 + \frac{Y}{M}\right)^{K-1} + \frac{DSC}{E}}\right] - \left(\frac{A}{E} \times \frac{CPN\%}{M}\right)$$

238 B: More About Calculations

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, then the coupon payments will also fall on the last day of the month. For example, a semiannual bond that matures on September 30 will have coupon payment dates on March 31 and September 30.
- If the maturity date of a semiannual bond falls on August 29 or 30, then the February coupon payment dates will fall on the last day of February (28, or 29 in leap years).

### **Depreciation Calculations**

For the given year, YR#:

$$ACRS = \frac{ACRS\%}{100} \times BASIS$$

$$SL = \frac{BASIS - SALV}{LIFE}$$

$$SOYD = \frac{BASIS - SALV}{LIFE \times \frac{(LIFE + 1)}{2}} \times (LIFE - YR\# + 1)$$

$$DB = \frac{BASIS \times FACT\%/100}{LIFE} \times \left(1 - \frac{(FACT\%/100)}{LIFE}\right)^{(YR\# - 1)}$$

For the last year of depreciation, *DB* equals the remaining depreciable value for the prior year.

### **Sum and Statistics**

n = number of items in the list. x' = an element of the sorted list.

$$TOTAL = \Sigma x_i \qquad MEAN = \bar{x} = \frac{\Sigma x_i}{n}$$

$$MEDIAN = x_j' \text{ for odd } n, \text{ where } j = \frac{n+1}{2}$$

$$MEDIAN = \frac{(x_j' + x_{j+1}')}{2} \text{ for even } n, \text{ where } j = \frac{n}{2}$$

$$STDEV = \sqrt{\frac{\Sigma (x_i - \bar{x})^2}{n-1}}$$

 $W.MN = \frac{\Sigma (y_i x_i)}{\Sigma y_i} \qquad G.SD = \sqrt{\frac{\Sigma y_i x_i^2 - (\Sigma y_i) \overline{x}^2}{(\Sigma y_i) - 1}}$ 

$$RANGE = MAX - MIN$$

# Forecasting

	Model	Transformation	X,	Yi
LIN	y = B + Mx	y = B + Mx	x <sub>i</sub>	y <sub>i</sub>
EXP	$y = Be^{Mx}$	$\ln y = \ln B + Mx$	x <sub>i</sub>	ln y <sub>i</sub>
LOG	$y = B + M \ln x$	$y = B + M \ln x$	ln x <sub>i</sub>	y <sub>i</sub>
PWR	$y = Bx^M$	$\ln y = \ln B + M \ln x$	ln x <sub>i</sub>	ln y <sub>i</sub>

Let:

$$\overline{X} = \frac{\Sigma X_i}{n}$$
  $\overline{Y} = \frac{\Sigma Y_i}{n}$ 

$$SX2 = \Sigma (X_i - \overline{X})^2 \qquad SY2 = \Sigma (Y_i - \overline{Y})^2$$
$$SXY = \Sigma (X_i - \overline{X}) (Y_i - \overline{Y})$$

#### 240 B: More About Calculations

Then:  $M = \frac{SXY}{SX2}$ 

B = b for LIN and LOG models, and  $B = e^{b}$  for EXP and PWR models,

where  $b = \overline{Y} - M \overline{X}$ .

$$CORR = \frac{SXY}{\sqrt{SX2 \times SY2}}$$

# **Equations Used in Chapter 13**

### **Canadian Mortgages**

$$PV = -PMT \left[ \frac{1 - (1 + r)^{-N}}{r} \right] - FV (1 + r)^{-N}$$
  
where:  $r = \left[ \left( 1 + \frac{CI\%YR}{200} \right)^{\frac{1}{6}} - 1 \right]$   
 $N = \text{total number of monthly payments}$   
 $CI\%YR = \text{annual interest rate (as a percent)}$   
 $PV = \text{loan amount}$   
 $PMT = \text{monthly payment}$   
 $FV = \text{balloon payment}$ 

### **Odd-Period Calculations**

$$PV\left[1 + i \times \frac{DAYS}{30}\right] =$$

$$F(1 + i \times S) \times PMT \times \left[\frac{1 - (1 + i)^{-N}}{i}\right] - FV(1 + i)^{-N}$$

where: PV = loan amount

i = periodic interest rate as a decimal DAYS = actual number of days until the first payment PMT = periodic payment amount N = total number of payments FV = balloon payment amount S = 1 if DAYS < 30S = 0 if  $DAYS \ge 30$ 

### **Advance Payments**

$$PMT = \frac{-PV - FV (1 + i)^{-N}}{\left[\frac{1 - (1 + i)^{-(N - \#ADV)}}{i} + \#ADV\right]}$$

where: PMT = payment amount

PV = loan amount

FV = balloon payment amount

i = periodic interest rate (as a decimal)

N = total number of payments

#ADV = number of payments made in advance

### **Modified Internal Rate of Return**

$$MIRR = 100 \left[ \left( \frac{NFV_p}{-NPV_N} \right)^{1/n} - 1 \right]$$

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

#### 242 B: More About Calculations

# С

# Menu Maps

The following maps show how to display each of the menus. There is a map for each menu label in the MAIN menu and for each menu found on the keyboard. The menu labels for variables are enclosed in boxes to illustrate how they are used:



Variable used to store and 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.



Figure C-1. BUS Menu







Figure C-2 (continued). FIN Menu



Figure C-3. SUM Menu


#### Figure C-5. SOLVE Menu



Figure C-6. DSP, MATH, MODES, and PRINTER Menus

# **Error Messages**

The calculator beeps and displays an error message under certain circumstances—for example, when you attempt an operation that is not allowed.

The calculator distinguishes between math errors that occur on the calculator line and other types of messages by preceding math-error messages with the word ERROR:.

Press **CLR** or **(** to erase the message and restore the previous display.

BAD GUESSES: PRESS ECLRJ TO VIEW The Solver cannot begin a numerical search using the initial estimates. See pages 167 and 227.

BATT TOO LOW TO PRINT To conserve battery power, the calculator will not transmit data to the printer until fresh batteries have been installed.

CURRENT LIST UNNAMED; NAME OR CLEAR THE LIST Attempted to get another list without first clearing or naming the current list. Press CLEAR DATA to clear it or NAME to name it.

EMPTY LIST Attempted a calculation using an empty CFLO or SUM list. ERROR: LOGARITHM(NEG)

ERROR: LOGARITHM(0)

Attempted to take the base 10 or natural log of a negative number or zero. This can happen during curve-fitting calculations if you attempt to calculate:

- A logarithmic forecasting model with a negative or zero *x*-value.
- An exponential model with a negative or zero *y*-value.
- A power model with a negative or zero *x* or *y*-value.

ERROR: NEG^NONINTEGER Attempted to raise a negative number to a non-integer power.

ERROR: OVERFLOW An internal result in a calculation was too large for the calculator to handle.

ERROR: SORT(NEG) Attempted to take the square root of a negative number or calculate *G.SD* given any negative frequencies.

ERROR: UNDERFLOW An internal result in a calculation was too small for the calculator to handle.

ERROR: 0^NEG Attempted to raise zero to a negative power.

ERROR: 0÷0 Attempted to divide zero by zero.

ERROR: 0^0 Attempted to raise zero to the zero power.

ERROR:  $\div 0$ Attempted to divide by zero.

### INPUTS CAUSED ÷0

The numbers stored into built-in variables caused a division by zero in the calculation. You must change one or more stored values. (Refer to the equations in appendix B to see which variables appear in the divisor.)

### INSUFFICIENT DATA

- Attempted to calculate standard deviation with only one value in the list.
- Attempted to do curve fitting using an x-variable list in which all the values are equal.
- Attempted to do curve fitting using the logarithmic or power models with a list for which the transformed values of x (ln x) are equal.

### INSUFFICIENT MEMORY

The calculator has insufficient memory available to do the operation you've specified. Refer to "Managing Calculator Memory" on page 216 for additional information.

### INTEREST <= -100%

One of the following values for interest is less than or equal to -100:

- **TVM menu:**  $I\%YR \div P/YR$ .
- PER menu: EFF% ÷ P (calculating EFF%); EFF% (calculating NOM%).
- CONT menu: *EFF*%.
- CFLO menu: *I*% (calculating *NPV*, *NUS*, or *NFV*) or estimate of *IRR*%.

#### INTERRUPTED

Calculation of *I*%YR, *IRR*%, amortization results, a Solver variable, or a SUM-list sort was interrupted.

### INVALID DATE

The number entered cannot be interpreted as a proper date. Check its format (page 132). Attempted to set a date outside the range 1/1/1987 through 12/31/2086, or attempted date arithmetic outside the range 10/15/1582 through 12/31/9999.

#### INVALID EQUATION

- The Solver cannot interpret the equation due to a syntax error. Refer to "What Can Appear in an Equation," page 154.
- A variable's name is invalid. Refer to "Names of Variables," page 155.

INVALID INPUT

- Attempted to store into a built-in variable a number that is outside the range of values permitted for that variable.
- The number entered cannot be interpreted as a proper time.
- The appointment's repeat interval is out of range.
- Attempted to enter a non-integer, negative number when specifying the number of displayed decimal places (in DSP).

INVALID N Attempted to calculate I%YR with  $N \le 0.99999$  or  $N \ge 10^{10}$ .

IRR% >  $\emptyset$  EXISTS; KEY IN GUESS; ESTOJ (IRR%) Calculation of *IRR%* produced a negative answer, but the calculator has determined that there is also a unique positive answer. (Refer to page 226.)

MACHINE RESET The calculator has been reset (page 214, 217).

#### MANY OR NO SOLUTIONS

The calculator 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 to calculate *IRR*%.

MANY/NO SOLUTIONS; KEY IN GUESS; ESTOI (IRR%) The calculation of *IRR%* is complex, and requires you to store a guess. (Refer to page 227.)

MEMORY LOST Continuous Memory has been erased (page 214, 218).

NAME ALREADY USED: TYPE A NAME; [INPUT] The list name name you've attempted to enter is already in use; type in a new name and press INPUT].

#### NO SOLUTION

No solution is possible using the values stored in the current built-in menu or list. This most commonly results from an incorrect sign for a cash flow or other monetary value. (Review page 53.)

#### N! N<0 OR N NONINTEGER

Attempted to calculate the factorial of a negative or non-integer value.

#### OVERFLOW

A warning—*not an error*—that the magnitude of a result is too large for the calculator to handle, so it returns  $\pm 9.99999999999999499$  rounded to the current display format. See page 44 for limits.

### SOLUTION NOT FOUND

No solution was found for a Solver equation using the current values stored in its variables. Refer to page 234 in appendix B.

#### UNDERFLOW

A warning—*not an error*—that the magnitude of a result is too small for the calculator to handle, so it returns the value zero. See page 44 for limits.

UNEQUAL LIST LENGTHS Attempted a two-list SUM calculation using lists of unequal lengths.

# Index

For index entries with multiple references, page numbers in **bold** type indicate primary references.

## A

ABS (absolute value) function, 157 ACCRU , 98 Accrued interest, on bond, 98, 99 Accuracy of the clock, 218 Acknowledging appointments, 136 ACRS% , 104 ACRS , 104 Actual calendar actuarial equations, 235 for arithmetic, 138 for bonds, 98 Addition, 19 ADJST menu, 133 Advance payments, 63-66, 187-189, 242. See also Leasing Algebraic rules in equations, 153–154 ALL key, 31 ALOG, 157 Alphabetic keys, 28-29 ALPHAbetic menu, 27 Amortization calculations, 67-70 equations, 236-237 schedule, 68 schedule, printing, 71-72 AM/PM format, 132 AMRT menu, **67** AND operator, 155, **162** Annual percentage interest rate

in TVM, 52 with fees, 181 Annunciators, 16 definition, 17 printer, 171 Antilogarithms, 39, 157 A/PM , appointment-setting menu, 132 Appointment menus, 131, 133–134 messages, 135 repeat interval, 135, 136 -setting menu, 134 Appointments acknowledging, 136 clearing, 137 memory used by, 217 messages, 133 past due, 134 printing, 175 setting, 134-136 unacknowledged, 134, 136 APPT menu, **134** APT1 through APT6 , 134 Arithmetic priority, 142 Arithmetic, 19–20, 35 in registers and variables, 43 Arrow keys for changing current equation, 144 for editing, 29

Arrow Keys (continued) for finding an equation, 150 for rolling the history stack, 40 for viewing long equations, 154

### В

в , 121 Backspace key, 18 BAL , 67 Balance of loan, 69-70 Balloon payment, 54, 59-60 **BASIS** , 104 Batteries, changing, 214–216 Battery life, 214 annunciator, 214 Beeper on and off, 33 Beeper, 136 BEG , 53 Begin payment mode, 53, 55 Beginning of list, in CFLO list, 87 BOND menu, 97-98 Bond calculations, 98–102 equations, 238 price, 100 type, 98, **99** yield, **100** fractional values for, 100 Bonds, 203-204 Bottom of the current list, in CFLO list, 84 of the Solver list, 150 Braces in equations, 155 Brackets in equations, 155 Brightness of the display, 16 Built-in variables. See Variables, built-in BUS menu, 45, 243 Business variables, clearing, 45 Buy option, for a lease, 64-66 B-value, in curve fitting, 121

## С

CALC menu in CFLO menu, 90 in SOLVE menu, 146-147 in SUM menu, 117 in TIME menu, 138 CALC in CFLO menu, 81 in SOLVE menu, 145 in SUM menu, 111 in TIME menu, 131 Calculator line arithmetic in, 35-44 definition, 17 displaying alphabetic information, 28-29 editing, 18 Calculator not functioning, 219-220 Technical Support, 211 resetting, 214, 217-218 Calendar basis, 97-98 Calendar. See also Date 360-day, 138 365-day, 138 actual, 138 range of, 138 Call, 98, 101 CALL , 98 Canadian mortgage, 185-187, 241 Capitalized value of a lease, 63-64 Cash flow calculations, 80-96 equations, 237-238 list. See CFLO list Cash flow diagrams in cash flow calculations, 82-83 in TVM calculations, 53-55 Cash flows equal. See Cash flows, grouped grouped, 83, 93 initial, 83, 84

CFLO list (continued) maximum number of, 80 sum of, 90 ungrouped, 82 zero, 83, 84 CDATE, 157 CFLO list CALC menu, 90 clearing, 89 copying from, 87 correcting, 87 creating, 83 definition, 80 deleting numbers, 87 editing, 81, 87 entering numbers in, 84-86 GETing a new list, 88 inserting numbers, 87 name, clearing, 89 naming, 87-88 printing, 174 signs of numbers, 82 starting a new list, 88 viewing the name of the current list, 88 viewing numbers, 87 Chain calculations, 19, 35-36 Changing batteries, 213-216 the sign of a number, 20 Characters for equation names, 149 in equations, 154-155 inserting and deleting, 28-29 for CFLO list, 87-88 for SUM list, 115-116 Checking calculator operation, 219-221 %CHG menu, 46 Chi-squared, 208-210 CLEAR DATA , 18, 25–26 Clearing, 18 AMRT variables, 69 appointments, 135, 137

BOND variables, 98 BUS variables, 45 calculator memory, 25-26 CFLO lists, 84, 89 %CHG variables, 45 the history stack, 40 **ICONV** variables, 75 menu variables, 25 menus, 25 MU%C variables, 45 MU%P variables, 45 Solver variables, 151 SUM lists, 112 %T variables, 45 TIME CALC variables, 138 TVM variables, 53 variables, 25-26 Clock. See Time CLR, 16, 18, 29 Commas, in numbers, 32 Compound interest calculations, 50 Compounding annual, **60** monthly, 56, 57, 59, 63, 64 periods, 50, 51, 52, 53 periods, vs. payment periods, **77–79**, 189 rates, 73 semimonthly, 62 Conditional expressions, 161-163 Constants in equations, 155 CONT menu, 75 Continuous compounding, calculating interest for, 74 Continuous Memory, 34 erasing, **214**, 218 using, 16 Contrast of display, changing, 16 Conventional investments, definition, 90 Converting interest rates, 74-76 CORR , 121 Correlation coefficient, 121 COST key, 48-49

Cost of capital, 90 markup on, 45, 47-48 Counter variable, in summation function, 163 Coupon basis, 97-98 payments, 97 CPN% , 98 Creating a CFLO list, 83-86, 88 a new equation, in the Solver, 145-146 a SUM list, 112-113, 116 CTIME, 157 Current equation, 144 deleting, 151-152 printing, 175 Cursor, 17 movement keys, 29 Curve fitting, 110, 121-123 calculations, 123-126 equations, 240 Customer Support, 211

### D

Date arithmetic, 138-140 Date format, 132, 133 for appointments, 133 DATE in appointment-setting menu, 134 in SET menu, 132 Date in the past or future, 140 setting, 132-133 viewing, 130 DATE, Solver, 157 DATE1 , 138 DATE2, 138 Day of the week, determining, 138 Day.month.year format, 132, 133 DAYS , 138 DB , 104 DDAYS, 157 Decimal places, 31, 44 Decimal point, 32

Declining balance depreciation. See Depreciation DEL , 29 DELET in CFLO menu, 81 in Solver menu, 145, 152 in SUM menu, **111**, 116 Deleting all information, 214, **217–218** characters, 29 equations, 151-152 from a CFLO list, 87, 89 from a SUM list, 114, 116 variables in the Solver, 151-152 Dependent variable, 123 DEPRC menu, 103 Depreciation ACRS method, 103, 107-108 calculations, 103-109 declining balance method, 103, 105-106 equations, 239 partial year, 108-109 straight line, 103, 105 sum of the years' digits, 103, 105 Diagnostic self-test, 220-221 Diagrams, cash flow, 53-55, 82-83 Digit separator, 32 Direct solutions in Solver, 166, 228, 229 - 230Discount rate, 90 Display clearing, 18 contrast, 16 format, 30 messages, 33 organization, 17, 40 printing the contents of, 172 turning on and off, **16** Displayed messages, 249 Displaying the contents of registers, 40-43 values assigned to variables, 25 Division, 35-37 DSP menu, 30 DSP menu, 32, 248

### Ε

E key, **44** EDIT , 145, 149 Editing alphabetic information, 28-29 equations, 149 keys, 28-29 EFF% key, 77-75 Effective interest rate, 73-76, 89 E, in numbers, 44 Electronic interference, 224–225 End payment mode, 53, 54 END , 53 Ending value, in summation function, 163 English languages, setting, 213 Entering equations, 145-146 Entering guesses in the Solver, 168-170 Entering numbers in a SUM list, **112–113** into CFLO lists, 84-86 Environmental limits, 219 Equals sign, used to complete calculations, 19, 35 Equation list. See Solver list Equation Solver, 141-170, 228-235 clearing, 151 introduction, 26 Equations algebraic rules, 153 for built-in menus, 235–242 characters in, 154-155 clearing, 151 deleting, 151-152 displaying, 150 editing, 149 entering, 145 erasing, 151 invalid, 146 length of, **141** long, viewing, **154** memory used by, 217 naming, 149

verifying, 145-146 writing, 153 Erasing. See also Clearing; Deleting Erasing calculator memory, 214, 217-218 Error messages, 249, 33 Estimates, entering in the Solver, 168-170 Examples, 178 EXIT, 25 EXP, 157 EXP , 39 EXPM1, 157 Exponential model, 119, 121, **122** Exponential numbers, 44 Exponentiation, 38–39 in equations, 153

### F

Face value, bond, 98 FACT%, 104 FACT, 157 Factorial, 39, 157 FIN menu, 244-245 FIX key, 31 FLOW, Solver, 157 Forecasting calculations, 119-126 equations, 240-241 values, 110, 121-123 Foreign languages, 213 Formatting numbers, 30 FP, 157 Fractional part, 157 FRCST menu, 119, 121 FRCST , 117 Functions in equations, 155, 157–159 Future date, calculating, 140 Future value of a series of payments, equation, 235 Solver function, 159 FV key, 52

## G

General business calculations, 45-49 equations, 236 GET , in CFLO, 88 GET , in SUM, 116 GO , 71 Grouped standard deviation, 126-128 G.SD , 121 Guesses entering in the Solver, 168-170 *IRR*%, entering, 226-228 Solver, 234

## Η

Halting a numerical search, 168
Heirarchy of menus, 21
HELP

in the appointment-setting menu, 134
in the SET menu, 132

Hierarchy of operations, in equations, 153
History stack 40

printing, 173
HMS, 158
HP Solve. See Solver
HRS, 158
Humidity requirements, 219

## 

I%, 89
I?, 90
ICNV

equations, 237
menu, 73–74
variables, clearing, 75

IDIV, 158
IF, 158, 161–162

nested, 163
IN, 158

Independent variable, 123

Individual Retirement Account, 62-63 [INPUT], 87 in CFLO menu, 81 for storing equations, 27 in the Solver list, 145-146 in SUM list, 112 Inserting characters, 29 INSR in CFLO list, 81, 87 in SUM list, 111, 113 Installing batteries, 214-216 Insufficient memory, 34, 216 Insurance policy, price, 201–203 INT , 67 Interest compound, 50, 73 equations, 237 on loan, amount of PMT applied toward, 69-70 simple, 50 Interest rate conversions, 73-79, 189, 237 effective and nominal, 73 Internal rate of return. See also IRR% calculations, 80, 86, 89-90 Interrupting an IRR% calculation, 227 Interrupting the Solver, 168 INT, rounded in amortization calculations, 68 INV, 158 Invalid equation, 146 Investments calculating IRR% and NPV of, 90-92 with grouped cash flows, 93-95 IP, 158 IRA, 62-63, 198 IRR%, 89, 90, 198 IRR% , 90 IRR% calculations, 226-228 halting, 227

IRR% estimate making, 227-228 seeing current, 227
IRR% solutions, types of, 226-227
ITEM, 158
Iteration in Solver, 167-170, 228, 230-235
IXYR key, 52

### L

Language, setting, 213 Large numbers, keying in and displaying, 44 Largest number in a list, **117** available, 44 Last result, copying, 41 LAST , 41 Leasing, 63-66, 187-189 LEFT-RIGHT, interpreting, 230–233 Letter keys, 27 LIFE , 104 LIN , 121 Linear estimation, 110, 121-123 Linear model, 119, 122 Linear regression, 110 List. See CFLO list; SUM list; Solver list LIST , 173 LN, 158 LN , 39 LNP1, 158 Loan amortizing, 67-72 APR for, with fees, 181 calculations, 56-60 interest-only, 182 odd-period, 183, 184-185 LOG, 158 LOG , 39 Logarithms, 39, 157 Logarithmic model, 119, 121, 122 Logical operators, 162

Low memory, 216-217 Low power, 214 and printing, 172 annunciator, 172

### Μ

M , 121 MAIN menu, 17, 20-21 MAIN, 20-23 Manual, organization of, 15 Markup on cost, 45, 47-48 on price, 45, 48 MAT , 98 Math in equations, 153, 155 MATH menu, 39, **248** MAX , 117 MAX, 158 M%C , 48 M%P , 48 M/D , 48 MEAN , 117 Mean, 239 calculating, **117–119** weighted, 126-128 Median, 239-240 calculating, 117-119 MEDN , 117 MEM key, 34 Memory. See also Continuous Memory Memory freeing, 216-217 insuffcient, 216 losing, **214**, 218 requirements, 218 size, **216** using and reusing, 34 Menu keys, 20 labels, **17** maps, 22, 243-248

Menus calculations with, 23-25 changing, 22, 25 exiting, 25 names of, 149 printing values stored in, 174-175 sharing variables, 48-49 using, 20-26 Messages for appointments, 135 memory used by, 217 Messages, error, 249 MIN , 117 MIN, Solver, 158 MOD, **158** Mode of payments (Begin and End), 53 Models, curve-fitting, **121**, 122 MODES, 172 MODES menu, 248 Modified IRR, 198-201, 242 MODL , 121 Month/day/year format, 132-133 MORE key, 22 Mortgage, 57, 59. See also Loan calculations, 56-60, 67-69 discounted on premium, 179 Moving average, 206–208 MSG in appointment setting menu, 134 in printer menu, 173 MU%C, **46** equation, 236 Multiple equations, linking, 165 Multiplication in arithmetic, 19, 35-37 in equations, 153 MU%P, 46 equation, 236

### Ν

N , 52 NI , 39

NAME in CFLO list, 87-88 in SUM list, 115-116 Names of equations, 149 of lists, clearing, 89 of variables, 155 Negative numbers in arithmetic calculations, 20 in cash-flow calculations, 82-83 in TVM calculations, 53 Neighbors in Solver, 231 Nested IF function, in the Solver, 163 Net future value, 80, 90 Net present value, 80, 90 Net uniform series, 80, 90 \*NEW key, 8 NEW , 145 NEXT , 67 NFV calculating, 80, 90 equation, 237 NFV , 90 N, non-integer, 52, 62 NOM% , 74-75 Nominal interest rate, 73-76, 89 Non-integer period, 160 NOT, 162 Notes, discounted, 205–206 NPV , 90 NPV calculating, 89-90 equation, 89, 237 NSR , 81 Number of days between dates, 138-139 of decimal points, 44 lists. See CFLO list; SUM list; Solver list of payments, in TVM, 52 range, 44 Numbers. See also Values with Exponents, 44

Numerical solutions, **166–169** NUS, **89**, 237 NUS , **90** 

## 0

Odd-period calculations, 160-161, 183, 242 OFF, 16-17 OLD, 46 ON, 16 Operators, in equations, 153-155 Option to buy, for a lease, 63-64 OR, 162 Order of calculation, in the Solver, 153 OTHER menu, 52-53 Overdue appointments. See Past-due appointments Overview, 3

### Ρ

**#P** , **67-68**, 71 P,74 Parentheses in arithmetic calculations, 36-37 in equations, 153, 155 PART , 47 Partial period. See also Odd period payments, 52 Past dates, calculating, 140 Past due appointments definition, 134 acknowledging, **136** Payment mode, 51 changing, 52 definition, 54-55 resetting, 53 Payment periods, 51, 52, 53 in cash flow calculations, 82 compounding, 50-53 vs. compounding periods, 77-79, 189

Payments amortization of, 67-70 lease, **63–66** number per year, in TVM, 52 TVM, 52 Percent, 37 change, 45-47 of cost, 45, 47-48 key for simple interest, 37, 50 of total, 45, 47 Percentage calculations, 45-49 Periodic compounding, calculating interest rates for, 74-75 Periodic interest rate, 90 Periodic rate of return, 89 Periods. See also Payment periods in numbers, 32 PI, 39, 158 PI , 39 PMT. See also Payments in TVM, 52 rounded amortization calculations, 68 PMT , 52 Positive numbers in cash flow calculations, 82-83 in TVM, 53 Power curve, 119, 121, 122 Power on and off, 16 Power. See also Low power; Batteries Power, raising a number to, 38 Precision of numbers, internal, 31 Present value definition, 52 of a lease, 63-66 of a series of payments, 159, 235 of a single payment, 159, 235 Previous menu, displaying, 25 PRICE , 48, 98 PRICE, as a shared variable, **48–49** Price, markup on, 45, 48 **PRIN** , 67 Principal of loan, amount of PMT applied toward, 69-70

PRINTER menu, 173, 248 Printer port, 171 **PRINTER** , 173 Printer power for, 172 using, 171 Printing amortization table, 71-72 appointments, 175 the display, 172 equations, 175 history stack, 173 interrupting, 177 messages, 175 of number lists, 174 slow, 171 the Solver list, 175 speed, 172 statistical values, 174 time and date, 173 variables, 174 with tracing, 176 Prompting for #TIMES, 85 [PRT], 172 Purchase date, bond, 98 Purchase price, in mortgage calculations, 57-58 PV, rounded in amortization calculations, 68 PWR , 110, 121 P/YR , 52

## Q–R

Questions, common, 211-213 Radio frequency interference, 224-225 Radix (decimal point), 31 RAND, 117 Range of numbers, 44 calculating, 117 Rate of return, periodic, 89 RCL, **42-43**, 87 with variables, 25 Recalling numbers, 42-43 from variables, 25 with LAST , 41 Reciprocal key, 38 Register storage, 42-43 Registers arithmetic in, 43 printing the contents of, 173 **REGS** , 173 Regulatory information, 224–225 Relational operators, 162 Remaining depreciable value, 104, 105Renaming lists. See CFLO list; SUM list; the Solver list Repeating appointments past-due, 136 setting, 135 Replacing batteries, 214-216 Required rate of return, 90 Resetting the calculator, 217 Reusing calculator memory, 34, 218 RND, 158 Root of a number, 38 Rounding a PMT, 60 Rounding numbers, 30-31 RPT , 134 Running total, 112-113

## S

S (function), 158 SALV, 104 Sample standard deviation, 117 Saving numbers, 40 Savings account, 60–62 college, 191–194 regular, 189–190 tax free, 195–198 Savings calculations, 60–63 Scientific notation, 44

Self-test, 220-221 Service charge for, 223 contracts, 224 determining if necessary, 219-220 obtaining, 222-224 warranty on, 221-222 SET menu, 132 SET , 131 SETT , 98 Setting an appointment, 134-136 Settings, default start-up, 218 Settlement date, 98 SGN, 158 Shared variables in BUS, 48-49 in ICNV, 75 in equations, 150 Shift, 17 Shipping instructions, for service, 223-224 <mark>SHOW</mark>, 31 Sign of numbers in TVM calculations, 53 in cash-flow calculations, 82 Simple interest, 37 with annual rate, 178 SIZE , 121 SL , 104 Slope, in curve-fitting, **121**, 123 Small numbers, keying in and displaying, 44 Smallest number available, 44 in a list, 117 SOLVE menu, 247 Solver, **141–170**. See also Equations Solver calculations, 143, 146-147 creating custom menus, 141-142 how it works, 166-170 multiple solutions in, 167 using, 141-156 technical discussion of, 228-235

Solver estimates, seeing current, 228-235 Solver functions, 157-159 Solver list clearing, 151-152 current equation, 144 definition, 141 deleting equations, 145, 151-152 deleting variables from, 151-152 editing an equation, 145 empty, 144 entering equations, 145-146 printing, 175 Solver menu, 144-145 for multiple equations, 165 Solver solutions, types of, 231-235 Solver variables. See Variables, Solver SORT , 117 Sorting numbers, 117 SOYD , 104 Spaces in equations, 154 Specifying the number of decimal places, 31 SPFV, 159, 235 SQ, 159 SQRT, 159 Square root calculating, 38 Solver, 159 Square, Solver, 159 Squaring a number, 38 Stack. See History stack Standard deviation, 100, **118-119** calculating, 117-119 grouped, **126–128** Starting value, in summation function, 163 Statistical equations, 239-241 Statistical calculations, 116-129 Statistical variables, 117, 119–123 Statistics, x and y, 119–123 **STDEV** , 117 Step size, in summation function, 163 STK , 173

STO, **42-43** Storage registers, 42–43 arithmetic in, 43 printing the contents of, 173 Storing numbers, 41, 42-43 in built-in variables, 25 Subtraction, 19, 35-37 SUM equations, 239-240 SUM items, maximum number of, 110 SUM list clearing, 116 CALC menu, 117 clearing numbers, 113 copying a number from, 115 correcting, 113 creating, 112-113 definition, 110-111 deleting numbers, 114 editing, 111, 113-114 entering numbers in, 112-113 FRCST menu, 121 GETing a new list, 116 inserting numbers, 113 largest number in, 117 name, deleting, 116 naming, **115** printing, 174 smallest number in, 117 sorting, 110, 117 starting a new list, 116 viewing numbers, 113 viewing the name of the current list, 116 SUM menu, 111-112, 246 Sum of cash flows, 90 Summation, 121, 129, 159, 163-164 function, in the Solver, 163-165, 209 of lists, 165 values, 121, **129** Switching menus, 22-23

## T

#T, 159 %T , 47 #T? , 84 TABLE, 67 Temperature requirements, **219** Testing the calculator, 219-222 Text, printing (MSG), 173 TIME menu, 130–131 Time value of money calculations, 50-72 equations, 236 Time accuracy, 218 changing, 132–133 and date, printing, 173 of day, viewing, 130 format, 133, 134-135 setting, 132-133 TIME in appointment-setting menu, 134 in PRINTER menu, 173 in SET menu, 132 #TIMES, prompting, 85-86 **TODAY** , 138 Top of the equation list, in the Solver, 150 TOTAL , 47 of a SUM list, 111, 117 Total, percent of, 47 TOTAL, sum of cash flows, 90 %TOTL, 45, **47 TRACE** , 173 Trace-printing, 176 TRN, **159** Troubleshooting, 211–213, 219–222 True population standard deviation, 117 Truncating function, in the Solver, 159 Turning the calculator on and off, 16 TVM instructions, **55–56** calculations, **50–72** equation, **236** menu, **50–53**, 55 variables, clearing, **53** TYPE , **98** Typing aids, **155** Typing alphabetic characters, **27** 

### U

Unacknowledged appointments, **136-134** Unit conversions, in the Solver, **166** Unknown variables in Solver, **229**, 230 Up-arrow key, **40** USFV, **159**, 235

## V–W

Values clearing, 25-26. See also CLEAR DATA recalling, 25, 42-43 storing, 25, 42-43 transferring between menus, 25 Variable, dependent, 123 independent, 123 Variables, built-in, 24 printing, 174 shared, 48-49 statistical, 117, 119-123 Variables, Solver, 142 clearing, 151 deleting, 152 names of, 155 shared, 150 Verifying equations, 145-146 Viewing lists. See CFLO list; SUM list; Solver list Warranty information, 221-222

Weighted mean, 121, **126-128** 

# X–Z

XOR, 162 x-values, in forecasting, 122–123 Yield to call, bonds, 97 of lease, 63–64 to maturity, bonds, 97 y-intercept, in curve-fitting, 121, 123 YLDZ, 98 YR#, 104 y-values, in forecasting, 122–123 Zero-coupon bond, 102

## **Special Characters**

((•)) alarm annunciator, 136 low-battery annunciator, 16,172, 214 print annunciator, 171 🕒 shift annunciator, 17 10^% , 39 12/24, 132 360D , 138 365D , 138 , 17 . , 32 , , 32 =, 162 [+/\_], **20**, 24 +HR , 133 -MIN , 133 -, 44 [1/x], 38 $\left[\sqrt{x}\right]$ , 38 **%**, 37 XCH , 46 \*CHG , 45, 46-47 %CHG menu formula, 236 using, **46** \*TOTL , 45, 47

%TOTL menu
formula, <b>236</b>
using, <b>47</b>
*NEW , 116
#P , 67
<b>#T</b> ? , <b>81</b> , 85-86
#TIMES, 85-86
Σ, <b>121</b> , 129, 159, <b>163–164</b> , 209
<b>EXY</b> , <b>121</b> , 129
ΣX , <b>121</b> , 129
<b>XX2</b> , <b>121</b> , 129
ΣΥ , <b>121</b> , 129
ΣY2 , <b>121</b> , 129
<ul><li>●, 18, 29</li></ul>
< or > , 162
▲ or ▼, <b>40</b>
with history stack, <b>40</b>
in a list, 85, <b>150</b>
editing a list, 87
-> , ->> , <- , <<- ,
29

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# Contents

Page	3	Welcome to the HP-17B
	12	List of Examples
	15	How to Use This Manual
	16	1: Getting Started
	35	2: Arithmetic
	45	3: Percentage Calculations in Business
	50	4: Time Value of Money
	73	5: Interest Rate Conversions
	80	6: Cash Flow Calculations
	97	7: Bonds
	103	8: Depreciation
	110	9: Running Total and Statistics
	130	10: Time, Appointments, and Date Arithmetic
	141	11: The Equation Solver
	171	12: Printing
	178	13: Additional Examples
	211	A: Assistance, Batteries, Memory, and Service
	226	B: More About Calculations
	243	C: Menu Maps
	249	Error Messages
	254	Index



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