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HEWLETT-PACKARD

**HP-80**

**Owner's Handbook**

Hewlett-Packard's interest in computation evolved as a natural extension of our traditional involvement in measurement problem solving. At an early date, HP recognized the growing need for a family of computational products designed to work easily and effectively with scientific instruments.

In 1966 we introduced the first digital minicomputer specifically designed to meet this need. Soon after, we followed up with our first programmable calculator. From these beginnings, HP has now become an acknowledged leader in the field of computational problem solving. More than 20,000 HP programmable calculators and digital computers are at work in a wide range of applications in science, industry, education, medicine, and business. Their effectiveness is further enhanced by a complete line of accessory devices, ranging from digital tape and disc drives to card and tape readers, printers, and plotters.

Now we've coupled our experience in scientific problem solving and computational technology to bring you new dimensions in personal computing—the *HP-35 Scientific Pocket Calculator* for engineering/scientific applications (*with tens of thousands in the field*), and the *HP-80 Business Pocket Calculator* for solving problems in business and finance.

## Attention Please!

Even though your pocket calculator is simple to operate, and you can start solving problems immediately by following the accessory *Quick Reference Guide*, there are some things you should know to get the most out of your **HP-80**.

Please read the Table of Contents and Introduction to become familiar with the territory. Next read through the General Operating Instructions. Then go back to the Table of Contents, look up the application you want to use, turn to the applicable pages, and do the sample problems on your *HP-80* according to the step-by-step instructions. It isn't necessary to read anything else. (*We included some design philosophy in the back of your handbook because we know that some users are crazy about details. Also, it gives us a chance to show off.*)

Now you can take a mental vacation because you have this trustworthy electronic business partner who will be handling things while you're gone.

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## Introduction

When Charles Lamb wasn't writing literary classics, he labored as an accountant for the East India Company. During his dual career—1791 to 1825—he often expressed a dim view of the business of business as it was when the standard calculating equipment consisted of a high stool, desk, quill pen, and a human brain—"I had perpetually a dread of some crisis to which I should be found unequal . . . I served over again all night in my sleep, and would awake with terrors of imaginary false entries, errors in my accounts, and the like . . ."



There is little doubt that Lamb's frustration with the burdens of his work sparked his creative genius—had he been content he might never have written anything of lasting significance. (In fact, his retirement from the East India Company marked the end of his productive period as a writer.)

At the risk of depriving the world of another businessman-cum-artist, we have produced a device that takes the drudgery out of complex financial and business calculations—and makes them more accurate, too. The tool is the **HP-80** electronic answer-machine that weighs only nine ounces (*you can take it anywhere you go—and should*), and replaces stacks of tricky tables and other such "inundata". It is the first pocket calculator to offer built-in logic for solving business-oriented problems. There is no comparable tool available today!






To give you a sample of what you can do with the HP-80, switch the calculator to ON and we'll work a typical compound interest problem. Suppose you wanted to calculate the effective annual rate of return on an investment as a basis for evaluating various investment opportunities. If you could buy property today for \$10,000 and could expect to sell it in 7 years for \$15,000, what would be the annual rate of return on your original investment? To solve, simply enter the known values as follows:

Key in 7 (number of years) and press **n** (number of periods in terms of time), key in 10000 (initial investment) and press **PV** (present value), key in 15000 (amount to be returned) and press **FV** (future value), then press **i** (interest). Find your answer (annual rate of return) on the display: **5.96 %**



If you want to see your answer showing six decimal places, press the gold key , key in 6, and see displayed:  %

Compare that with the painful procedure used with the existing calculation method:

| Conventional Method   | HP-80 Method   |
|---|--|
| <p>Use basic formula:</p> $S = P(1 + i)^n$ $(1 + i)^n = \frac{S}{P}$ <p>where:</p> <p>S = future value<br/>P = present value<br/>i = effective periodic rate<br/>n = number of periods</p> <p>Thus:</p> $(1 + i)^n = \frac{\$15000}{\$10000} = 1.50$ <p>Next, consult compound interest table to find the table value closest to 1.5000000. The table value of 5% for seven years is 1.4071004227, while the value for 6% is 1.5036302590. Therefore, the exact annual rate of return is somewhere between 5% and 6%.</p> <p>Now for interpolation (note that since method used is linear interpolation, the answer is only approximate). Let:</p> <p>X = amount between actual and low value<br/>.01 (or 1%) = difference between two table values<br/>.0928995773 = difference between lower table amount of 1.4071004227 and actual of 1.50<br/>.0965298363 = difference between higher and lower table amounts.</p> <p>Then, set up the equation as a proportion:</p> $\frac{X}{.01} = \frac{.0928995773}{.0965298363}$ <p>Cross-multiply:</p> $.0965298363X = .01 \times .0928995773$ $= .000928995773$ <p>Divide by .0965298363:</p> $X = \frac{.000928995773}{.0965298363}$ $= .00962392363448 \text{ or } .96\%$ <p>Finally:</p> <p>Annual rate of return = lower table rate of 5% + .96% or 5.96%.</p> | <p>Key in:</p> <p>7  10000  15000  </p> <p>Find answer displayed:</p> <p> %</p> |

Here are some other problems you can solve that are just as easy with the HP-80 (and just as tedious with conventional methods):

- All types of simple and compound interest calculations
- All types of percentage calculations
- Statistical applications (mean and standard deviation)
- All types of present value, future value, and effective rate calculations
- Sum-of-the-digits amortization (finance charges, depreciation)
- Add-on interest to effective annual rate conversion
- Effective yield calculations
- Mortgage calculations
- Discounted cash flow analyses
- Bond price and yield-to-maturity calculations
- Time interval, future date calculations
- Linear regression analysis (trend line forecasting) applications
- Square root calculations

In addition to its more exotic features, the HP-80 is fast, accurate, and convenient to use. It handles numbers as small as  $10^{-99}$  (that's a decimal point followed by 98 zeros and a 1), and numbers as large as  $10^{99}$  (1 followed by 99 zeros), automatically places the decimal point, and allows you to round the display to settings ranging from zero to six decimal places. It does everything a conventional four-function desk calculator does, too.

Unlike Charles Lamb, HP-80 users may never produce works of art as an outlet for job-related frustration. They may have to settle for something more modest—say president of the World Bank?

# General Operating Instructions

## Getting Started

Your HP-80 is shipped fully-assembled with battery pack in place and is ready to operate. Slide the power switch to ON. If anything other than **0.00** appears on the display, see Service, Appendix F.

In the HP-80, arithmetic answers appear on the display immediately after pressing a **+**, **-**, **×**, or **÷** key. In an adding machine, the **+** key adds the last entry to whatever is already in the machine, and the **-** key subtracts this last entry. The HP-80 not only adds and subtracts the same way as the old familiar adding machine, it also multiplies and divides this way too—the **×** multiplies the last entry by whatever is already in the machine, and the **÷** key divides by the last entry.

The display blinks when logic or range errors are made. Whenever this happens, clear the display by pressing **CLx**; **0.00** appears on the display and a new problem may be entered.

## Keyboard Description

Figure 1 illustrates the keyboard layout and classifies the keys according to type and function. Although most of the keys will be familiar to you, some require further explanation because of the unique features of the HP-80.

### Number Entry Keys

**0** through **9** **.**

### Number Control Keys

Seven keys are provided for manipulating numbers:

**SAVE** **↑** saves the number appearing on the display for arithmetic and basic calculations; terminates a number entry. (Pages 13 and 52.)

**R↓** rolls down and displays (*in last-in/first-out order*) whatever four numbers have been entered and are currently in the machine—one number with each press of the **R↓** key. Permits review of previous entries or results. (Pages 16 and 54.)

**x↔y** interchanges the last number previously saved with the number currently displayed; the former number reappears on the display. (Pages 17 and 54.)

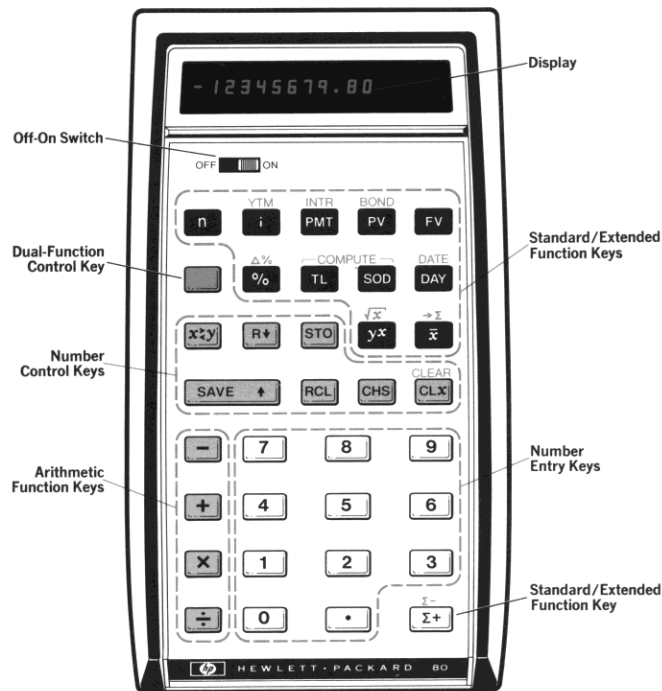


Figure 1. Keyboard Layout

**STO** stores the number appearing on the display for use as a constant value in deferred arithmetic and basic calculations. (Page 14.)

**RCL** recalls or retrieves a copy of a number previously stored with **STO** key; places it on the display so that it may be used in a calculation. (Pages 14 and 17.)

**CHS** changes sign of a displayed number from  $+$  to  $-$  or  $-$  to  $+$ . The  $+$  sign is not displayed; it is assumed if no sign appears on the display. (Page 13.)

**CLEAR**  
**CLX** clears display only; **CLEAR** clears everything except values stored as constants. (Page 15.)

### Arithmetic Function Keys



### Dual-Function Control Key (Gold Key)

The unlabeled gold key extends or expands the use of those function keys having gold-lettered notations above them. It is used also to clear the machine when used in conjunction with the **CLX** key, and to round numbers to various decimal places when used with number entry keys.

To use the alternate function (*the one on top*) merely press before pressing the associated function key.

### Standard/Extended Function Keys

Three groups of function keys are provided to perform complex operations automatically on numbers entered. These are:

#### 1. Basic Keys



#### 2. Financial Keys



#### 3. Interactive Keys:



## Fundamental Operations

Operations common to a number of applications are defined in the following paragraphs; they are described in depth in Appendixes A and B.

### Entering Data

Numbers appear from left to right on the display in the order in which they were pressed. Note that a decimal point is included with the number entry keys; it must be entered if it is part of the number. For example, \$2.98 would be keyed as: .

Each time a number is pressed it appears on the display. To signal that you have completed entry of a number string, press the non-numeral key appropriate to your present calculation.

If you want to enter a very large number—say 1 trillion—press 1000000000000. The number is displayed as . This represents  $1 \times 10$  raised to the 12th power—an example of scientific notation where large numbers appear in an abbreviated form using an exponent of 10 in the last two digits displayed.

### Entering Negative Numbers

To enter a negative number, press **CHS** (*change sign key*) after entering a positive number. The number will appear on the display preceded by a minus ( $-$ ) sign. To change the sign of a negative or positive number on the display press **CHS**.

### Rounding Numbers

A secondary function of all numeral keys is the rounding of displayed numbers. Numbers may be rounded on the display to a maximum of six decimal places by pressing the gold key before pressing the appropriate number key (0-6). Rounding affects the display only; it does *not* affect the accuracy of the number internally. Numbers may be displayed in scientific notation by pressing and then pressing the 7, 8 or 9.

### Loading Data

All calculations performed on more than one number require that numbers be loaded into appropriate memory locations.

### Arithmetic and Basic Functions

When performing arithmetic and basic functions, the first number in each set of values is loaded by pressing **SAVE** after entering the num-

ber. Subsequent numbers are handled automatically by pressing an arithmetic or basic function key (  $+$  ,  $-$  ,  $\%$  , etc.)

### Financial and Interactive Functions

All entries using the financial and interactive keys are loaded automatically when you press the key identifying the entry type (  $n$  ,  $i$  ,  $\Sigma+$  , etc.) after you have entered the number.

### Storing Constant Values

A constant value, whether keyed in or appearing on the display as a result of a previous calculation, may be stored in a special constant storage location from which it may be recalled and used in subsequent calculations. To store a constant, press **STO**; to recall it, press **RCL**. A copy of the recalled number appears on the display; the original value remains in the constant storage location.

The **STO** feature makes it easy to—say add several numbers, store the result, and then divide the individual numbers by the stored sum without having to reenter this constant value for each iteration. The storage location is changed by writing over it with a new constant value or may be cleared by turning the power switch off then on.

A number stored with **STO** is not affected by computations or by data stored in other locations except when the key triggering the result is pressed during certain special operations requiring larger memory area. The affected applications are:

- Rate of Interest for Sinking Fund
- Bond Price
- Bond Yield
- Sum-of-the-Digits Depreciation
- Annual Effective Rate of Interest on Installment Loans
- Converting Add-on Interest to Effective Annual Rate
- Accrued Interest
- Discounted Note
- Accumulated Interest Between Two Points—Remaining Principal.
- Rebates on Consumer Loans (*Rule of 78's*)
- Linear Regression Analysis (*Trend Line*)
- Discounted Cash Flow Analysis

### Clearing Data

Entries can be cleared as follows:

Financial function entries can be cleared before or immediately after they are loaded by pressing **CLx**.

All other entries can be cleared before they are loaded by pressing **CLx**. After these entries are loaded, they can be cleared by pressing **CLx**; the problem must then be reentered.

A blinking error signal can be cleared by pressing **CLx**.

Constant storage is cleared by turning the calculator off then on, or by writing over the present contents; that is, by storing a new number.

It isn't always necessary to clear the calculator (**CLx**)—when starting a new calculation—although it is usually comforting.

There are, however, certain applications that require clearing the calculator before performing the calculation. They are:

- Discounted Cash Flow Analysis
- Mean, Standard Deviation
- Linear Regression (*Trend Line*) Analysis

### Performing Simple Arithmetic

In the HP-80, arithmetic answers appear immediately after pressing any one of the arithmetic keys:  $+$   $-$   $\times$   $\div$

For example, add 12 and 3.

**Enter:** 12 **SAVE +** 3 **+** **See Displayed:** 15.00

Did you notice that you calculated this sum in the same order in which you would ordinarily do it with pencil and paper? That's right—you keyed in 12 and separated it from the next number to be keyed in (3) by pressing **SAVE +** after the 12. Then you pressed 3 followed by **+** to get the answer.

This same principle is used for calculating any arithmetic problem having two numbers and one arithmetic operator.

For example, subtract 3 from 12.

**Enter:** 12 **SAVE +** 3 **-** **See Displayed:** 9.00

To multiply 12 by 3,

**Enter:**  
12 **SAVE** 3 **×** → **See Displayed:** 36.00

To divide 12 by 3,

**Enter:**  
12 **SAVE** 3 **÷** → **See Displayed:** 4.00

In addition to the simple problems you have just performed, the HP-80 also handles combined arithmetic processes:

- Automatic Doubling      ■ Serial Calculation
- Automatic Squaring      ■ Chained Calculation

These problems are described in Appendix B.

## Manipulating Data

Seven keys (*excluding keys used to load entries in special operations*) are used to control the location of data and the movement of data between locations. Four of these keys are related to entering and deleting numbers: **SAVE** is used to load data; **STO** stores a constant value; **CHS** changes the sign of a displayed number; **CLX** clears data.

The remaining three keys (**R↓**, **x↔y**, **RCL**) are used to control the location of data after it has been loaded (*or stored, in the case of STO*).

Through the ability to manipulate the location of data, you are able to view the contents, can see intermediate results to problems, and have greater operating flexibility.

## Reviewing/Verifying Data Entered

The **R↓** (*roll down*) key permits you to review the previous entries or results—the last three preceding numbers to be loaded and the current entry. Each time **R↓** is pressed, one of those numbers appears on the display in last-in/first-out order. No data are lost by rotating those numbers; after a complete circuit, they will return to the same locations they occupied before rotation. For example,

| Enter:                                      | See Displayed: |
|---|----------------|
| 1 <b>SAVE</b> 2 <b>SAVE</b> 3 <b>SAVE</b> 4 | 4.             |
| <b>R↓</b>                                   | 3.00           |
| <b>R↓</b>                                   | 2.00           |
| <b>R↓</b>                                   | 1.00           |
| <b>R↓</b>                                   | 4.00           |

## Reversing Operand Order

You will often find that you want to do a subtract or divide operation where the number displayed should be interchanged with a previously displayed number to permit the desired calculation. This is accomplished by pressing the **x↔y** key to reverse the order of the operands by exchanging the contents of the two applicable locations. For example, if you want to divide 25 by 4, and the latter number is already on the display,

| Enter:        | See Displayed: |
|---------------|----------------|
| 4 <b>SAVE</b> | 4.00           |
| 25 <b>x↔y</b> | 4.00           |
| <b>÷</b>      | 6.25           |

## Recalling a Constant Value from Storage


The **RCL** key copies the stored constant value into the display, for use as an operand in repetitive calculation. **RCL** must be pressed each time the constant is to be used.

Whatever was previously displayed in the machine is automatically saved (*loaded*) when you press **RCL** so you are now ready to press any desired arithmetic function key, such as **+**, **−**, **×**, **÷**. For example, add 8, 20, 17, 43; store the result; and divide the individual numbers by the stored sum to find what part each is of the total.

| Enter:  | See Displayed:       |
|---|----------------------|
| 8 <b>SAVE</b> 20 <b>+</b> 17 <b>+</b> 43 <b>+</b> | 88.00 total          |
| <b>STO</b>  |                      |
| 8 <b>RCL</b> <b>÷</b>                             | 0.09 or 9% of total  |
| 20 <b>RCL</b> <b>÷</b>                            | 0.23 or 23% of total |
| 17 <b>RCL</b> <b>÷</b>                            | 0.19 or 19% of total |
| 43 <b>RCL</b> <b>÷</b>                            | 0.48 or 49% of total |

## Basic Functions

### Calculating Square Root

To calculate the square root of a positive number, enter the number, press the gold key  followed by **y<sup>x</sup>**. For example, what is the square root of 49?

**Enter:** 49  $\sqrt{x}$   $y^x$   $\longrightarrow$  **See Displayed:** 7.00  
 To compute  $\sqrt{3^2 + 4^2}$ ,

**Enter:** 3  $\text{SAVE} \uparrow$   $\times$  4  $\text{SAVE} \uparrow$   $\times$   $+$   $\sqrt{x}$   $y^x$   $\longrightarrow$  **See Displayed:** 5.00

### Calculating Percentage Problems

To avoid confusion relative to percentage problems, the following terms are defined in accordance with those most commonly used by the business community:

When finding a fractional part of a given number, the number is called the *base*, the fractional part is called the *rate* or *percent*, and the result is called the *percentage*. When adding the percentage to, or subtracting it from, the base, the result is called the *net amount*.

The HP-80 simplifies the calculation of percentage problems because you *don't have to convert percents* to their decimal equivalents before using them; just press the  $\%$  key after keying in the percent value.

Three types of percentage problems are handled:

- Finding percentage of number (*base  $\times$  rate*)
- Finding net amount (*base  $+$  or  $-$  percentage*)
- Finding percent difference between a number and the base ( *$(\text{number} - \text{base}) \div \text{base}$* )

**Finding Percentage:** To find the percentage of a number, enter the base number and press  $\text{SAVE} \uparrow$ . Then enter the percent, press  $\%$ . For example, to find 14% of \$300,

**Enter:** 300  $\text{SAVE} \uparrow$  14  $\%$   $\longrightarrow$  **See Displayed:** \$ 42.00 percentage

**Finding Net Amount:** An additional feature is that after finding the percentage, the HP-80 still contains the original base number from which you may calculate the net amount (*such as base price plus tax, or list price less discount*) by simply pressing a  $+$  or  $-$ , respectively.

For example,

**Enter:** 300  $\text{SAVE} \uparrow$  14  $\%$   $\longrightarrow$  **See Displayed:** \$ 42.00 percentage  
 $+$   $\longrightarrow$  \$ 342.00 net amount (*base plus percentage*)

or,

**Enter:** 300  $\text{SAVE} \uparrow$  14  $\%$   $\longrightarrow$  **See Displayed:** \$ 42.00 percentage  
 $-$   $\longrightarrow$  \$ 258.00 net amount (*base less percentage*)

**Finding Percent Difference Between Any Number and the Base:** To find the percent difference between two numbers, enter the base number and press  $\text{SAVE} \uparrow$ . Enter the second number, press  $\Delta\%$   $\%$ . For example,

**Enter:** 60  $\text{SAVE} \uparrow$  240  $\Delta\%$   $\%$   $\longrightarrow$  **See Displayed:** 300.00 % (240 is 300% greater than 60)

### Raising a Number to a Power (Exponentiation)

The  $y^x$  key lets you raise a positive number to any power automatically. In many calculators you'd have to perform the serial calculation multiplying the base number a number of times equal to the exponent (*if you could do it at all!*). That is,  $8 \times 8 \times 8 \times 8 \times 8 \times 8$  means  $8^6$ . To make it easier, we have you enter the base number, press  $\text{SAVE} \uparrow$ , enter the value of the power to which the base number is to be raised, press  $y^x$  and the result is displayed. For example, to find the value of  $8^6$ ,

**Enter:** 8  $\text{SAVE} \uparrow$  6  $y^x$   $\longrightarrow$  **See Displayed:** 262144.00

To find the value of  $2^{-2.5}$ ,

**Enter:** 2  $\text{SAVE} \uparrow$  2.5  $\text{CHS}$   $y^x$   $\longrightarrow$  **See Displayed:** 0.18

Note the blurred display, as opposed to blinking, during the calculation. This indicates the calculator is busy, and occurs when performing  $y^x$  or other functions in the HP-80 which use  $y^x$ .

### Calculating Time Intervals

Another very useful function involves the **DAY** key. It will determine the number of calendar days between two dates—ranging from January 1, 1900 to December 31, 2099—and will check for range and logic errors. An example of the latter might be February 29, 1973 or February 30th of any year. An erroneous date—whether a logic or range error will cause the display to blink. The **DAY** key is used in much the same way as the other function keys except that the *following convention must be observed*:

Enter the month number. Follow it with a decimal point, followed by a two-numeral day number, followed by the full year number.

For example:

|                  |                     |           |
|------------------|---------------------|-----------|
| May 11, 1973     | would be entered as | 5.111973  |
| June 3, 1984     | would be entered as | 6.031984  |
| November 9, 2009 | would be entered as | 11.092009 |

Thus, to find the number of days between two dates, simply key in the first date and press **SAVE +**, key in the second date and press **DAY**. The answer, shown in days, is ready for other operations or input to another problem. For example, to find the exact number of days between December 10, 1974 and March 14, 1976,

**Enter:** 12.101974 **SAVE +** 3.141976 **DAY** → **See Displayed:** 460.00 number of days

### Calculating Future or Past Dates

You can find a future or past date in the range January 1, 1900 to December 31, 2099—given the number of days—without having to count knuckles or remember rhymes. (*You don't need to worry if the year entered is a leap year; leap year calculations are handled automatically.*) Here's how:

1. If you want the year number to be displayed, **set** rounding for 6 decimal places by pressing the gold key **6** (number key).
2. **Enter** the starting date according to the date convention (above). Press **SAVE +**.
3. **Enter** the number of days (press **CHS** if you're finding a past date).
4. Press **DATE DAY**.

For example, to find maturity date on a 120-day note issued May 6, 1973,

**Enter:** 6 → **See Displayed:** 0.000000 sets rounding for 6 decimal places

5.061973 **SAVE +** 120 **DATE DAY** → **See Displayed:** 9.031973 maturity date where:

9. = 9th month (September)  
03 = day  
1973 = year

If you want to perform a subsequent date operation on the result in the display, be sure to press **SAVE +** first or you'll get an error. Again, a logic or range error in a date entry will cause the display to blink.

### Determining Day of the Week

The day of the week (*Mon., Tues., etc.*) corresponding to future or past dates can be determined as follows:

1. **Enter** known date, press **SAVE +**.
2. **Enter** today's date, press **DAY SAVE +**.
3. **Enter** 7, press **÷**.
4. **Enter** displayed number (omit decimal portion), press **-**.
5. **Enter** 7, press **×** to get day factor.

If the known date is in the future, count forward from today by the day factor. For example, if today is Monday and the day factor is 6, the future day would be Sunday. If the known date is in the past, count backwards from today by the day factor.

Suppose today is Monday, January 22, 1973 and you wanted to find out what day it was when the stock market crashed on October 29, 1929,

**Enter:** 10.291929 **SAVE +** 1.221973 **DATE DAY SAVE +** 7 **÷** → **See Displayed:** 2255.86  
2255 **-** 7 **×** → **See Displayed:** 6.00 day factor

Today is Monday; count six days back to get Black Tuesday.

## Special Operations

If you followed instructions and read the Introduction, you have already seen a typical example of the scope and power of the HP-80. Just in case you're underwhelmed, and still think it's just another calculator, here's an additional example: Suppose you invested \$50,000 and were guaranteed a return of \$10,000 each year for seven years. Now, try to figure the annual rate of return by some ordinary method. Then do it on the HP-80 as follows,

**Enter:**  
7 **n** 10000 **PMT** 50000 **PV** **i** → **See Displayed:**  
9.20 % annual rate of return

If you want to verify this problem,

**Enter:**  
**STO**  
7 **n** **RCL** **i** 10000 **PMT** **PV** → \$ 50000.00 present value

The HP-80 has built-in logic that enables you to perform two broad classes of complex functions: (1) financial and (2) interactive.

Certain keys are used to perform these special functions. Some functions use keys from both the financial and interactive classifications—as well as keys from the basic classification. For example, discounted cash flow analysis and accumulated interest problems use both financial and interactive keys.

### Financial Functions

Financial functions are used primarily in investment and loan applications (*simple interest, compound interest, annuities and bond problems*). These problems require three known values to get a fourth value. After each value is entered, it is loaded by pressing the applicable top-row key that identifies the value. The fourth value is obtained by pressing the top-row key representing the unknown value. Interest is always an annual rate unless specified to the contrary.

The key set associated with these functions is illustrated in Fig. 2. (note that **SAVE** is not used to load values). You'll probably be surprised to learn that the five keys in Figure 2 represent 17 functions and replace all the compound interest, discount, bond and annuity tables commonly in use.

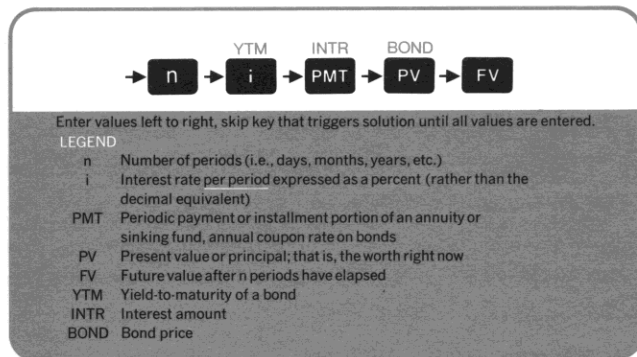


Figure 2. Financial Function Key Set

When using the top row financial keys, you may want to store one of the values you are entering for use in subsequent calculations. To do so just press **STO** before (but not after—this is an illegal operation) pressing the associated financial key, then proceed with your current financial calculation, and recall the stored value as needed by pressing

**RCL**.

### Interactive Functions

The interactive functions and associated keys are used primarily in applications concerned with constructing and dynamically modifying schedules, charts and tables, for example:

- Mean and Standard Deviation
- Linear Regression (*Trend Line*)
- Sum-of-the-Digits Amortization
- Interest Rebate Calculations

### Summation and Averaging Calculations

Summation/averaging calculations use the **Σ+** key (the letter "Σ"—sigma—is the Greek equivalent of our "S") to sum numbers for use in calculating means and standard deviations.

In addition, the  $\Sigma^+$  key is used to compute the sum of the squares of all your entries, and keeps track of the number of entries you've made. (To see how many entries you've made, simply press  $\Sigma y$ . But before you resume summing press  $\Sigma y$  again.)

The mean is calculated by pressing  $\bar{x}$ ; the alternate function of this key  $\bar{x}^{\rightarrow\Sigma}$  permits you to continue summing—thereby modifying the results of previous mean calculations.

We've also provided an error recovery routine in case incorrect data is entered. To correct your last entry calculation, after pressing  $\Sigma^+$ , reenter the *incorrect* value and press  $\bar{x}^{\rightarrow\Sigma}$ ; you are back where you were before the incorrect entry. Note that a value must be entered prior to each  $\Sigma^+$  keystroke or errors will result.

#### Sum-of-Digits Calculations

The sum-of-the-digits key  $\Sigma OD$  is used to calculate an amortization schedule and related balances for consumer finance charges or depreciation of capital assets.

Amortization on a period-by-period basis as well as the remaining balance after any given period can be obtained. Furthermore, you have the option of finding this information at any point in the amortized life span and can obtain values for all subsequent periods if you wish.

#### Trend Line Calculations

To forecast or estimate trends, you may chart a straight line of best fit through data points across a periodic (*daily, weekly, etc.*) time span. This type of analysis is made possible through the  $\Sigma TL$  (*trend line*) key. The HP-80 calculates the course of a straight trend line by operating on chronologically-entered data, and then projecting the line to any point.

## Applications

### Investments

The following applications use the financial keys pressed in left to right order to obtain solutions. Some of the applications use interactive and basic keys also. As in ordinary tables, the number of years and interest rate must be converted to reflect the number of compounding periods if different from those specified. When converting years to periods, multiply the years by the number of compounding periods per year, and load the result by pressing  $n$ . When converting an interest rate to its periodic equivalent, divide the rate by the number of compounding periods per year and load the result by pressing  $i$ . Then proceed with the calculation.

### Compounded Amounts

#### Future Value of Compounded Amount

This calculation finds the future value of an amount compounded at a certain interest rate over a specified number of periods. Information is entered as follows:

- ① Enter number of time periods, press  $n$ .
- ② Enter rate per period, press  $i$ .
- ③ Enter principal (*present value*), press  $PV$ .
- ④ Press  $FV$  to obtain the future value.

**Sample Case 1:** What is the future value of \$500 invested at 6% for 7 years if interest is compounded annually?

Solution

Enter: 7  $n$  6  $i$  500  $PV$   $FV$   $\rightarrow$  \$ **751.82** See Displayed:  
value in 7 years  
compounded annually

**Sample Case 2:** What is the future value of the same \$500 invested at the same rate (6%) for the same number of years (7) if compounded quarterly? The necessary intermediate calculations can be done in your head or as follows on the HP-80:

Solution

|                                     |   |                       |   |
|-------------------------------------|---|-----------------------|---|
| <b>Enter:</b>                       |   | <b>See Displayed:</b> |   |
| 7 <b>SAVE +</b> 4 <b>x</b> <b>n</b> | → | <b>28.00</b>          | number of periods (quarters) in 7 years |
| 6 <b>SAVE +</b> 4 <b>÷</b> <b>i</b> | → | <b>1.50</b>           | % interest rate per quarter             |
| 500 <b>PV</b> <b>FV</b>             | → | <b>\$ 758.61</b>      | value in 7 years compounded quarterly   |

### Present Value of Compounded Amount

This calculation finds the present value of a compounded amount when the future value, number of periods and interest rate are known. Information is entered as follows:

- ① Enter number of time periods, press **n**.
- ② Enter rate per period, press **i**.
- ③ Enter future value, press **FV**.
- ④ Press **PV** to obtain the present value (principal).

**Sample Case:** If you wanted to establish a fund of \$15,000 for an extended vacation which you planned to take in 2 years, what would be the investment required now if money is worth 4% compounded quarterly?

Solution

|                                     |   |                       |  |
|-------------------------------------|---|-----------------------|--|
| <b>Enter:</b>                       |   | <b>See Displayed:</b> |  |
| 2 <b>SAVE +</b> 4 <b>x</b> <b>n</b> | → | <b>8.00</b>           | number of periods (quarters) in 2 years  |
| 4 <b>SAVE +</b> 4 <b>÷</b> <b>i</b> | → | <b>1.00</b>           | % interest rate per quarter              |
| 15000 <b>FV</b> <b>PV</b>           | → | <b>\$ 13852.25</b>    | principal (present value) to be invested |

### Rate of Interest for Compounded Amount

This calculation finds the interest rate needed to amass a given sum if a fixed amount is invested for a specified period. Information is entered as follows:

- ① Enter the number of periods, press **n**.
- ② Enter the amount of investment, press **PV**.
- ③ Enter the sum required in the future, press **FV**.
- ④ Press **i** to obtain the required interest rate per period.

**Sample Case:** What annual rate of interest must be obtained in order to amass a total of \$10,000 in 10 years on an investment of \$6,000?

Solution

|   |   |                       |                        |
|---|---|-----------------------|------------------------|
| <b>Enter:</b>                                       |   | <b>See Displayed:</b> |                        |
| 10 <b>n</b> 6000 <b>PV</b> 10000 <b>FV</b> <b>i</b> | → | <b>5.24</b>           | % annual interest rate |

What if the interest were compounded daily (assume 365 days per year)?

|   |   |                       |   |
|---|---|-----------------------|---|
| <b>Enter:</b>                           |   | <b>See Displayed:</b> |   |
| 10 <b>SAVE +</b> 365 <b>x</b> <b>n</b>  | → | <b>3650.00</b>        | number of periods (days) in 10 years                  |
| 6000 <b>PV</b> 10000 <b>FV</b> <b>i</b> | → | <b>0.01</b>           | % daily interest rate (rounded to two decimal places) |
| 365 <b>x</b>                            | → | <b>5.11</b>           | % annual interest rate if compounded daily            |

### Number of Periods for Compounded Amount

This calculation finds the number of periods required to amass a given sum at a specified rate on a given investment. Information is entered as follows:

- ① Enter rate per period, press **i**.
- ② Enter present value, press **PV**.
- ③ Enter future value, press **FV**.
- ④ Press **n** to obtain number of periods.
- ⑤ If desired, enter number of periods per year, press **÷** to convert periods to years.

**Sample Case:** You now have \$887 in a savings account in your bank which is paying 5.4% compounded monthly. How long will it take to reach one million dollars?

Solution

|   |   |                       |                  |
|---|---|-----------------------|------------------|
| <b>Enter:</b>   |   | <b>See Displayed:</b> |                  |
| 5.4 <b>SAVE +</b> 12 <b>÷</b> <b>i</b> 887 <b>PV</b> 1000000 <b>FV</b> <b>n</b> | → | <b>1565.21</b>        | number of months |
| 12 <b>÷</b>   | → | <b>130.43</b>         | number of years  |

### Compounded Amount of Interest Earned

This calculation finds the interest earned (dollar amount), rather than rate of interest, on a fixed amount when the interest is compounded at a specified rate and period. Information is entered as follows:

- ① Enter number of periods, press **n**.
- ② Enter interest rate, press **i**.
- ③ Enter principal (present value), press **STO**, **PV**.
- ④ Press **FV** to obtain future value.
- ⑤ Press **RCL**, **-** to obtain dollar amount of interest.

**Sample Case:** What would be the net amount and interest earned on \$500 at 5% for 2 years if interest is compounded quarterly?

Solution

Enter: 2 **SAVE** 4 **X** **n** → See Displayed: 8.00 number of periods (quarters) in 2 years

5 **SAVE** 4 **÷** **i** → 1.25 % interest rate per quarter

500 **STO** **PV** **FV** → \$ 552.24 net amount (future value)

**RCL** **-** → \$ 52.24 interest earned

### Nominal Rate Converted to Effective Annual Rate

This calculation finds the effective annual interest rate when the number of periods per year and the nominal (stated) annual interest rate are known. Information is entered as follows:

- ① Enter number of periods per year, press **STO**, **n**.
- ② Enter nominal rate, press **RCL**, **÷**, **i**.
- ③ Enter 100, press **STO**, **PV**, **FV**.
- ④ Press **RCL**, **-** to obtain effective annual rate.

**Sample Case:** What is the effective annual rate of interest if the nominal (annual) rate of 12% is compounded quarterly?

Solution

Enter: 4 **STO** **n** 12 **RCL** **÷** **i** → See Displayed:

100 **STO** **PV** **FV** **RCL** **-** → 12.55 % effective annual interest rate

### Effective Annual Rate Converted to Nominal Rate

This calculation finds the nominal (annual) rate of interest when the number of periods per year and the effective annual interest rate are known. Information is entered as follows:

- ① Enter number of periods per year, press **STO**, **n**.
- ② Enter 100, press **SAVE**, **PV**.
- ③ Enter effective annual rate, press **+**, **FV**, **i**.
- ④ Press **RCL**, **X** to get nominal rate.

**Sample Case:** Find the nominal rate if the effective annual rate is 12.55%, compounded quarterly (4 periods).

Solution

Enter: 4 **STO** **n** 100 **SAVE** **PV** → See Displayed:

12.55 **+** **FV** **i** **RCL** **X** → 12.00 % nominal rate of interest

### Annuities

#### Future Value of Annuity (Sinking Fund)

This calculation finds the amount to be amassed at the end of a specified number of periods where the amount of the periodic payment and interest rate per period are known. Information is entered as follows:

- ① Enter number of periods, press **n**.
- ② Enter interest rate per period, press **i**.
- ③ Enter amount of periodic payment, press **PMT**.
- ④ Press **FV** to obtain future value.

**Sample Case:** How much money will you have at the end of 5 years if you deposit \$250 per month in a savings account at 6% interest compounded monthly?

Solution

Enter: 12 **SAVE** 5 **X** **n** → See Displayed: 60.00 number of periods (months) in 5 years

6 **SAVE** 12 **÷** **i** → 0.50 % interest rate per month

250 **PMT** **FV** → \$ 17442.51 value in 5 years, compounded monthly

#### Rate of Interest for Sinking Fund

This calculation finds the rate of interest for a sinking fund when the amount to be amassed (future value), the number of time periods, and the periodic payment amount are known. The formula uses the constant storage location, therefore, any value stored there will be de-

stroyed when the final key (*the one that triggers the result*) is pressed. The information is entered as follows:

- ① Enter number of periods, press **n**.
- ② Enter amount of payment, press **PMT**.
- ③ Enter future value, press **FV**.
- ④ Press **i** to obtain required rate of interest per period.

**Sample Case:** What annual rate of interest must be obtained to amass a total of \$10,000 in 10 years on an annual investment of \$600?

Solution

Enter: 10 **n** 600 **PMT** 10000 **FV** **i** → See Displayed: 10.93 % annual interest rate

### Payment Amount for Sinking Fund

This calculation finds the periodic payment to be set aside for a sinking fund, when the future value, number of periods, and interest rate per period are known. Enter information as follows:

- ① Enter number of periods, press **n**.
- ② Enter interest rate per period, press **i**.
- ③ Enter future value, press **FV**.
- ④ Press **PMT** to obtain amount of periodic payment for sinking fund.

**Sample Case:** As a farsighted parent, you are planning ahead for your children's education. How much money must be invested each month to amass \$10,000 in 10 years, when interest is earned at a rate of 5% compounded monthly?

Solution

Enter: 10 **SAVE** 12 **x** **n** → See Displayed: 120.00 number of periods (months) in 10 years  
 5 **SAVE** 12 **÷** **i** → 0.42 % monthly interest rate  
 10000 **FV** **PMT** → \$ 64.40 monthly payment for sinking fund

### Present Value of Annuity

This calculation finds the principal (*present value*) when the number of periods, interest rate per period, and amount of the periodic payment are known. Information is entered as follows:

- ① Enter number of periods, press **n**.
- ② Enter interest rate per period, press **i**.
- ③ Enter amount of periodic payment, press **PMT**.
- ④ Press **PV** to obtain amount of principal (*present value*).

**Sample Case 1:** If you decide to buy a car for which you plan to pay \$80 per month for 36 months, and you are willing to pay 6% annual interest, how much can you afford to pay for the car?

Solution

Enter: 36 **n** 6 **SAVE** 12 **÷** **i** 80 **PMT** **PV** → See Displayed: \$ 2629.68  
 amount you can pay for car. (A Rolls-Royce is definitely out)

**Sample Case 2:** Bob Jones is the recipient of an inheritance from his father. The terms of the will are: (a) Bob may elect to receive \$1000 a year at the end of each year for the next twenty years or, (b) receive a lump sum of \$13,500 now. He assumes that inflation will erode the value of his money in either case, so he is holding the inflation factor as an unavoidable constant. He also assumes that money will be worth 4.75% on an annual basis. From a *financial* standpoint only, which alternative is better?

Solution

Enter: 20 **n** 4.75 **i** 1000 **PMT** **PV** → See Displayed: \$ 12730.67 present value  
 13500 **xy** **-** → \$ 769.33 difference between present value of annuity and lump sum (he takes the lump sum).

### Monthly Payment of Annuity (Direct Reduction Loan)

This calculation finds the periodic payment amount when the principal (*present value*), number of periods, and interest rate per period are known. Enter the information as follows:

- ① Enter number of periods, press **n**.
- ② Enter interest per period, press **i**.
- ③ Enter principal, press **PV**.
- ④ Press **PMT** to obtain amount of periodic payment.

**Sample Case:** If a member of a credit union borrows \$1800 to be repaid over 24 months at a 6% annual rate, what is his monthly payment?

**Enter:** 24 **n** 6 **SAVE +** 12 **÷** **i** 1800 **PV** **PMT** → \$ **79.78** per month

**See Displayed:**

## Bonds

The bond formulas used in the HP-80 assume a semiannual coupon payment. All bond prices are expressed as a percentage of the dollar value—whether entered or displayed—in accordance with trade custom.

The mathematical approach we use for bond problems is more precise than the traditional one established in the 1800's. The reason is that where the intra-coupon period is applicable to the problem, we use the *actual* number of days per month instead of an arbitrary 30 days for all months.

In deference to long standing custom, however, an option is provided for calculating bond problems in accordance with traditional trade custom. The traditional method is quite close to the actual and differs only beyond the second decimal places except for some extreme cases\*.

Both price calculations are accurate to the sixth decimal place (*that's down to the last penny on \$1 million*). Accuracy for yield problems is detailed in Appendix D.

Additional types of bond problems are described in Appendix C.

## Bond Price

This calculation finds the exact price of a bond based on the actual number of days, when the purchase date, maturity date, effective yield-to-maturity rate, and coupon rate are known. The formula uses the constant storage location, therefore, any value stored there will be destroyed when the final key (*the one that triggers the result*) is pressed. Enter the information as follows:

- ① **Enter** the settlement (or purchase) date (1- or 2-numeral month, decimal point, 2-numeral day, 4-numeral year), **press** **SAVE +**.
- ② **Enter** maturity date according to above convention, **press** **DAY**.
- ③ **Enter** effective yield-to-maturity rate, **press** **i**.
- ④ **Enter** annual coupon rate, **press** **PMT**.
- ⑤ **Press** **BOND**, then **PV**, to obtain the price of the bond.

\*For example, what is the price of a 3% bond to yield 10% if purchased on 1-1-72 and maturing on 10-1-72? **Actual** price should be...**95.06** **Traditional** price is...**95.05**

**Sample Case:** What is the price of a bond purchased January 23, 1973 (1.231973) that will mature March 6, 1978 (3.061978), and has a coupon rate of 4½% and a yield of 3.22% to maturity?

**Solution**

**Enter:** 1.231973 **SAVE +** 3.061978 **DAY** 3.22 **i**

**See Displayed:**

4.5 **PMT** **BOND** **PV** → **105.99** bond price (percentage)

The following calculation finds the price of a bond using the traditional method corresponding to the basis book, when the time to maturity (*in terms of years, months and days*) is known. Of course, the yield-to-maturity as well as the coupon rate are assumed to be known. Again, the formula uses the constant storage location, therefore, any value stored there will be destroyed when the final key (*the one that triggers the result*) is pressed. The information is entered as follows:

- ① **Enter** number of days (if none, enter 0), **press** **SAVE +**.
- ② **Enter** 30 (days/mo), **press** **÷**.
- ③ **Enter** number of months (if none, enter 0), **press** **+**.
- ④ **Enter** 12 (mo/yr), **press** **÷**.
- ⑤ **Enter** number of years (if none, enter 0), **press** **+**.
- ⑥ **Enter** 365, **press** **×** **n**.
- ⑦ **Enter** effective yield-to-maturity, **press** **i**.
- ⑧ **Enter** coupon rate, **press** **PMT**, **BOND** **PV** to obtain price.
- ⑨ **Press** **6** to obtain result displayed with 6 decimal places if desired.

**Note:** If the time to maturity is less than six months, skip steps ①-④, then convert time to days and press **n**. Continue with step ⑦.

**Sample Case:** What is the price of a 4% bond—to six decimal places (*in accordance with the basis book*)—yielding 3% and maturing in 9 years, 10 months and 15 days?

**Solution**

**Enter:** 15 **SAVE +** 30 **÷** 10 **+** 12 **÷** 9 **+** 365 **×** **n**

**See Displayed:**

3 **i** 4 **PMT** **BOND** **PV** → **108.49** bond price (percentage)

**6** → **108.489240** bond price extended to 6 decimal places

## Bond Yield

This calculation finds the yield-to-maturity (*in percent*) of a bond when the purchase date, maturity date, coupon rate and price (percentage) are known. (See Appendix D for accuracy specifications.) The formula uses the constant storage location, therefore, any value stored there will be destroyed when the final key (*the one that triggers the result*) is pressed. Information is entered as follows:

- ① Enter settlement date (1- or 2-numeral month, decimal point, 2-numeral day, 4-numeral year), press **SAVE +**.
- ② Enter maturity date (according to above convention), press **DAY**.
- ③ Enter annual coupon rate, press **PMT**.
- ④ Enter price (*present value*) of the bond, press **PV**.
- ⑤ Press **YTM**, then **i** to obtain the effective annual yield-to-maturity.

**Sample Case:** What is the yield-to-maturity of a bond purchased January 23, 1973 at a price of 106, that matures March 6, 1978 and has a coupon rate of 4½ %?

Solution

**Enter:** 1.231973 **SAVE +** 3.061978 **DAY**  
4.5 **PMT** 106 **PV** **YTM** **i** → **3.22 %** effective annual yield-to-maturity

The following calculation finds the yield-to-maturity of a bond when prices are obtained from the basis book, or when prices are computed in a manner compatible with basis book computations. It is assumed that time-to-maturity (*in years, months and days*) is known, as well as the coupon rate and price (*present value*). The constant storage location is used with this calculation also; any value stored there will be destroyed when the final key (*the one that triggers the result*) is pressed.

Information is entered as follows:

- ① Enter number of days (if none, enter 0), press **SAVE +**.
- ② Enter 30 (days/mo), press **÷**.
- ③ Enter number of months (if none, enter 0), press **+**.
- ④ Enter 12 (mo/yr), press **÷**.
- ⑤ Enter number of years (if none, enter 0), press **+**.
- ⑥ Enter 365, press **×** **n**.

- ⑦ Enter annual coupon rate, press **PMT**.
- ⑧ Enter price (*present value*) of the bond, press **PV**.
- ⑨ Press **YTM** **i** to obtain effective annual yield-to-maturity.

**Note:** If the time to maturity is less than six months, skip steps ①-④, then convert time to days and press **n**. Continue with step ⑦.

**Sample Case:** What is the yield-to-maturity of a 4% bond purchased at a price of 106.75 that matures in 9 years 10 months?

Solution

**Enter:** 10 **SAVE +** 12 **÷** 9 **+** 365 **×** **n** **YTM** **i** → **3.19 %** effective annual yield-to-maturity

## Depreciation

### Sum-of-the-Years' Digits Depreciation

This calculation finds the depreciation and remaining depreciable value for each year of an asset's depreciable life when the beginning-ending periods, and the asset's present value (*less salvage value*) are known. The formula uses the constant storage location, therefore, any value stored there will be destroyed when the final key (*the one that triggers the result*) is pressed. Information is entered as follows:

- ① Enter beginning year number (e.g., year 1), press **n**.
- ② Enter depreciable life of asset (in years), press **n**.
- ③ Enter present value of asset, press **PV**.
- ④ Press **COMPUTE**, then press **SOD** to obtain beginning year's depreciation.
- ⑤ Press **x2y** to obtain remaining depreciable value.
- ⑥ Press **x2y**, then press **SOD** to obtain next year's depreciation.
- ⑦ Press **x2y** to obtain remaining depreciable value.
- ⑧ Repeat steps ④ and ⑦ to obtain each subsequent year's depreciation and remaining depreciable value until the asset is completely depreciated or until the number of iterations is equal to the depreciable life of the asset (*in terms of years*).

**Note 1.** You can bypass the remaining depreciable value calculation by skipping steps ⑤-⑧, and can obtain each subsequent year's depreciation by pressing **SOD** repeatedly after completing step ④.

**Note 2.** You could have started calculating depreciation at any year within the depreciable life span of the asset. Furthermore, you can skip to any new starting point by simply entering the year number (e.g., year 4), pressing **n** and then pressing **SOD** through as many iterations as required to depreciate the asset completely.

**Sample Case 1:** A fleet car has a value (*less salvage value*) of \$2100 and a life expectancy of six years. Using the sum-of-the-years' digits method, what is the amount of depreciation and what is the depreciable value for each of the first two years?

Solution

| Enter:   | See Displayed:                       |
|--|--------------------------------------|
| 1 <b>n</b> 6 <b>n</b> 2100 <b>PV</b> <b>COMPUTE</b> <b>SOD</b> | \$ <b>600.00</b> year 1 depreciation |
| <b>x2y</b>   | \$ <b>1500.00</b> remaining value    |
| <b>x2y</b> <b>SOD</b>  | \$ <b>500.00</b> year 2 depreciation |
| <b>x2y</b>   | \$ <b>1000.00</b> remaining value    |

**Sample Case 2:** Using the values from Sample Case 1, what is the depreciation and depreciable value for years 3 through 6?

Solution

| Enter:   | See Displayed:                       |
|--|--------------------------------------|
| 3 <b>n</b> 6 <b>n</b> 2100 <b>PV</b> <b>COMPUTE</b> <b>SOD</b> | \$ <b>400.00</b> year 3 depreciation |
| <b>x2y</b>   | \$ <b>600.00</b> remaining value     |
| <b>x2y</b> <b>SOD</b>  | \$ <b>300.00</b> year 4 depreciation |
| <b>x2y</b>   | \$ <b>300.00</b> remaining value     |
| <b>x2y</b> <b>SOD</b>  | \$ <b>200.00</b> year 5 depreciation |
| <b>x2y</b>   | \$ <b>100.00</b> remaining value     |
| <b>x2y</b> <b>SOD</b>  | \$ <b>100.00</b> year 6 depreciation |
| <b>x2y</b>   | \$ <b>0.00</b> remaining value       |

### Declining Balance Depreciation

This calculation finds depreciation and remaining book value for each year of an asset's depreciable life when the present value, salvage value, and life expectancy are known. Declining balance calculations use the storage and recall features of the HP-80. Information is entered as follows:

- Enter declining factor, press **SAVE +**.
- Enter 100 (100% of depreciation), press **x**.
- Enter number of years, press **÷** to obtain multiplier.
- Press **STO**.
- Enter present value of asset.
- Press **RCL**, press **%** to obtain first year's depreciation.
- Press **-** to obtain remaining book value in first year.
- Repeat steps 4 and 7 to obtain each succeeding year's depreciation and remaining book value until the book value is equal to or less than the salvage value. In the latter case, the previous book value is reduced by the salvage value to obtain the final year's depreciation.

**Sample Case:** A fleet car has a value of \$2500, a salvage value of \$400 which is not deducted from the present value, and a life expectancy of six years. If you are using the double declining balance method, what is the amount of depreciation and book value for years 1-4?

Solution

| Enter:                                  | See Displayed:                         |
|---|--|
| 2 <b>SAVE +</b> 100 <b>x</b> 6 <b>÷</b> | <b>33.33</b> multiplier                |
| <b>STO</b> 2500 <b>RCL</b> <b>%</b>     | \$ <b>833.33</b> 1st year depreciation |
| <b>-</b>                                | \$ <b>1666.67</b> remaining book value |
| <b>RCL</b> <b>%</b>                     | \$ <b>555.56</b> 2nd year depreciation |
| <b>-</b>                                | \$ <b>1111.11</b> remaining book value |
| <b>RCL</b> <b>%</b>                     | \$ <b>370.37</b> 3rd year depreciation |
| <b>-</b>                                | \$ <b>740.74</b> remaining book value  |
| <b>RCL</b> <b>%</b>                     | \$ <b>246.91</b> 4th year depreciation |
| <b>-</b>                                | \$ <b>493.83</b> remaining book value  |

Note that an asset cannot be depreciated beyond salvage value—therefore, depreciation for year 5 would be \$93.83 and book value \$400.

### Discounted Cash Flow Analysis

For capital budgeting purposes, it is often required that a discounted cash flow analysis be performed to see if a particular investment is at least as profitable as some norm (*often called the cost of capital or discount rate*).

This calculation finds the present values of all the future cash flows (*appropriately discounted by cost of capital*) less original investment.

If the result is greater than or equal to zero, the venture is deemed to be profitable, at least to the extent of the discount rate or cost of capital.

Known values are the cost of capital (*in terms of percent*), the amount of the original investment (*present value*), and the expected cash flow schedule. The formula uses the constant storage location, therefore, any value stored there will be destroyed when the final key (*the one that triggers the result*) is pressed. Information is entered as follows:

- ① **Clear** the HP-80 by pressing **CLX**.
- ② **Enter** cost of capital (*percent*) per period, press **i**.
- ③ **Enter** original investment and press **CHS** to change it to a negative number indicating it is a capital outlay, press **PV**.
- ④ **Enter** first period's cash flow (*make it negative by pressing CHS if you're still putting money out*), press **PV**.
- ⑤ Press **Σ+** to obtain the current net present value (*the first cash flow less capital outlay*).
- ⑥ **Enter** second cash flow, press **PV**.
- ⑦ Press **Σ+** to obtain the current net present value (*the first and second cash flows, less capital outlay*).
- ⑧ Continue steps ⑥ and ⑦ until you run out of cash flows.

Notice the advantage of being able to tell in which period you will recover your investment (*if at all*) since, as soon as the display shows a positive number after a given cash flow, you have recovered your investment on a discounted cash flow basis.

**Sample Case:** You are offered an investment opportunity for \$100,000 at a capital cost of 10% after taxes.

Will this investment be profitable based on the following cash flows?

| Year | Cash Flow |
|------|-----------|
| 1    | \$34,000  |
| 2    | \$27,500  |
| 3    | \$59,700  |
| 4    | \$7,800   |

Solution

**Enter:** **CLX**  
 10 **i** 100000 **CHS** **PV** 34000 **PV** **Σ+** → **\$-69090.97** current net present value  
 27500 **PV** **Σ+** → **\$-46363.64** current net present value

59700 **PV** **Σ+** → **\$-1510.14** current net present value  
 7800 **PV** **Σ+** → **\$817.36** final value is positive; deal is OK.

## Loans

Just as in investment calculations, the following applications use the financial (*top-row*) keys, pressed in left to right order, for primary entries. In some cases, basic keys—as well as interactive keys—are used. Again, the number of years and interest rates must be converted to reflect the number of compounding periods if different from those stated.

### Annual Percentage Rate of Interest on Installment Loans

This calculation finds the true annual interest rate of a loan, when the number of periods, amount of each payment, number of installments and the principal are known. The formula uses the constant storage location, therefore, any value stored there will be destroyed when the final key (*the one that triggers the result*) is pressed. The information is entered as follows:

- ① **Enter** number of installments, press **n**.
- ② **Enter** amount of each installment, press **PMT**.
- ③ **Enter** principal, press **PV**.
- ④ Press **i** to obtain rate of interest *per installment*.
- ⑤ **Enter** number of installments per year, press **x** to obtain effective annual rate of interest.

**Sample Case:** If you borrow \$850 to be repaid in 52 equal weekly installments of \$20 each, what is the annual percentage rate of interest?

Solution

**Enter:** 52 **n** 20 **PMT** 850 **PV** **i** → **0.79** % weekly interest rate (rounded to two decimal places)  
 52 **x** → **41.12** % annual percentage rate

### Add-on Interest to Annual Percentage Rate Conversion

This calculation finds the annual percentage interest rate and the monthly payment factor when the number of periods (*months only in*

this application) and the add-on interest rate are known. The amount of monthly payment can be calculated also for any given principal. The formula uses the constant storage location, therefore, any value stored there will be destroyed when the final key (*the one that triggers the result*) is pressed. The information is entered as follows:

- ① Enter the number of months, press **n**.
- ② Enter the annual add-on interest rate, press **i**.
- ③ Press **i** again to obtain the annual percentage rate.
- ④ Press **x/y** to obtain monthly payment factor.
- ⑤ Enter principal, press **x** to obtain amount of monthly payment.

**Sample Case:** What is the true rate of interest (*annual percentage rate*) on an 18 month, 5% add-on loan? What would be the monthly payment on a principal of \$1500?

Solution

|                                 |   |
|---------------------------------|---|
| Enter:                          | See Displayed:  |
| 18 <b>n</b> 5 <b>i</b> <b>i</b> | <b>9.27</b> % annual percentage rate  |
| <b>x/y</b>                      | <b>0.06</b> monthly payment factor<br>(0.059722 if shown with 6 decimal places) |
| 1500 <b>x</b>                   | <b>\$89.58</b> monthly payment amount   |

### Accrued Interest

This calculation finds the amount of accrued interest on both a 360- and 365-day basis when the number of periods (*days only in this application*), interest rate, and principal (*present value*) are known. The formula uses the constant storage location, therefore, any value stored there will be destroyed when the final key (*the one that triggers the result*) is pressed. The information is entered as follows:

- ① Enter number of days, press **n**.
- ② Enter annual interest rate, press **i**.
- ③ Enter principal, press **PV**.
- ④ Press **INTR** **PMT** to obtain the amount of interest on a 360-day basis.
- ⑤ Press **x/y** to obtain the amount of interest on a 365-day basis.

**Sample Case:** What is the amount of accrued interest due on \$450 for 50 days at 7%, figured on a 360/365-day basis?

Solution

|   |                                       |
|---|---------------------------------------|
| Enter:  | See Displayed:                        |
| 50 <b>n</b> 7 <b>i</b> 450 <b>PV</b> <b>INTR</b> <b>PMT</b> | <b>\$ 4.38</b> interest—360-day basis |
| <b>x/y</b>  | <b>\$ 4.32</b> interest—365-day basis |

### Discounted Note

This calculation finds the discount amount (*interest*) and the effective annual yield on a note for both a 360- and 365-day basis, when the number of periods (*days only in this application*), discount rate and face value (*future value*) are known. The formula uses the constant storage location, therefore, any value stored there will be destroyed when the final key (*the one that triggers the result*) is pressed. The information is entered as follows:

- ① Enter the number of days, press **n**.
- ② Enter the annual interest rate, press **i**.
- ③ Enter the face value (*future value*) press **FV**.
- ④ Press **INTR** **PMT**, then **PMT** to obtain the discount amount on a 360-day basis.
- ⑤ Press **R+** to obtain the effective annual yield on a 360-day basis.
- ⑥ Press **R+** again to obtain discount amount on a 365-day basis.
- ⑦ Press **R+** again to obtain the effective annual yield on a 365-day basis.

**Sample Case:** What is the discount amount on a \$1000 face value note having 37 days until maturity at 6%? What is the effective annual yield?

Solution

|  |   |
|--|---|
| Enter:   | See Displayed:                                      |
| 37 <b>n</b> 6 <b>i</b> 1000 <b>FV</b> <b>INTR</b> <b>PMT</b> | <b>\$ 6.17</b> discount amount, 360-day basis       |
| <b>R+</b>  | <b>6.04</b> % effective annual yield, 360-day basis |
| <b>R+</b>  | <b>\$ 6.08</b> discount amount, 365-day basis       |
| <b>R+</b>  | <b>6.04</b> % effective annual yield, 365-day basis |

## Accumulated Interest Between Two Points, Remaining Principal

This calculation generates one of the more cumbersome sets of numbers found in actuarial amortizations (*direct reduction loans*) such as mortgages: the remaining principal to be paid, and the accumulated interest paid between any two points. Note that some mortgage holders round payments up to the nearest cent. Consequently the result of the remaining balance might differ from the actual amount as calculated on the HP-80.

The known values are: the payment numbers corresponding to the beginning and end of the time frame being analyzed, the total number of loan payments, interest rate per payment and amount of each payment (*just the principal and interest exclusive of any insurance or tax amounts*). The formula uses the constant storage location, therefore, any value stored there will be destroyed when the final key (*the one that triggers the result*) is pressed. Figure 3 illustrates a typical accumulated interest problem.

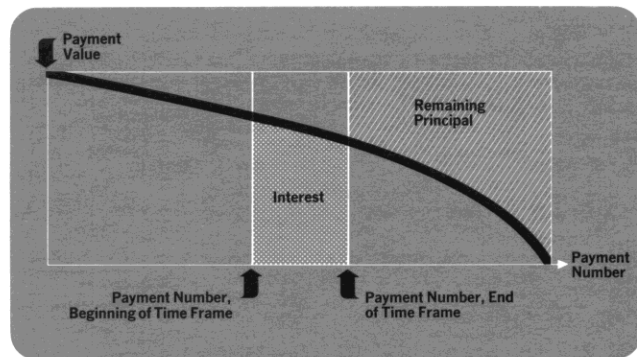


Figure 3. Accumulated Interest Problem

The information is entered as follows:

- ① **Enter** the payment number (less 1) associated with the beginning of the time frame, **press** **STO**.
- ② **Enter** the payment number associated with the end of the time frame, **press** **n**.
- ③ **Enter** total number of payments over the life of the loan, **press** **n**.
- ④ **Enter** the interest rate per payment (*annual interest rate divided by the number of periods in a year*), **press** **i**.
- ⑤ **Enter** amount of each periodic payment (*principal plus interest*), **press** **PMT**.
- ⑥ **Press** **Σ+** to obtain the sum of the interest paid over the period.
- ⑦ **Press** **xzy** to obtain the amount of principal you still owe (*we'd recommend sitting down for this one!*).

Note that the first three steps are for entering different period numbers. The entry sequence is easily remembered; just enter each value in ascending order.

**Sample Case:** You have a 30-year, 8% mortgage on your house in the amount of \$40,885 which you obtained 1 year ago. Monthly payments are \$300. What is the amount of interest paid during the taxable year just ended starting at payment 1 and ending at payment 12? What is the unpaid principal?

Solution

**Enter:** 0 **STO** 12 **n** 360 **n**  
 8 **SAVE** **↑** 12 **÷** **i** 300 **PMT** **Σ+** → \$ **3258.46** interest paid during applicable period  
**xzy** → \$ **40543.51** remaining principal

See Displayed:

## Rebates on Consumer Loans (Rule of 78's)

This calculation finds the unearned interest, as well as the balance due on the principal, for a prepaid consumer loan using the rule of 78's.

The known values are the current installment number, the total number of installments for which the loan was written, and the total finance charge (*amount of interest*). The formula uses the constant storage location, therefore, any value stored there will be destroyed when the final key (*the one that triggers the result*) is pressed. The information is entered as follows:

- ① Enter current or most recent payment number, press **n**.
- ② Enter total number of installments, press **n**.
- ③ Enter total amount of finance charge or interest fee, press **PV**.
- ④ Press **COMPUTE** **SOD** to obtain interest portion of final installment.
- ⑤ Press **xzY** to obtain unearned interest (*rebate amount*).
- ⑥ Enter the regular installment amount, press **SAVE +**.
- ⑦ Enter the number of installments remaining on the loan, press **x** **xzY** **-** to obtain the amount of principal outstanding.

**Sample Case:** A 30-month, \$1000 loan having a finance charge of \$180.00 is being repaid at \$39.33 per month. What is the interest portion of the 25th payment? What is the interest rebate at that point? What is the remaining principal?

Solution

**Enter:** 25 **n** 30 **n** 180 **PV** **COMPUTE** **SOD** → \$ **2.32** interest for payment 25  
**xzY** → \$ **5.81** unearned interest (*rebate*) for payment 26–30  
 39.33 **SAVE +** 5 **x** **xzY** **-** → \$ **190.84** amount of principal outstanding after payment 25

## Merchandising, Purchasing

### Cost and Price (Markup, Chain Discounts)

Among the most used business calculations are those related to establishing retail prices based upon costs, trade discounts and profit margins.

This calculation finds the amount of markup, net price, dealer discount and list price when the per unit manufacturing/purchase cost, profit margin and dealer discount rates are known. Information is entered as follows:

- ① Enter unit cost, press **SAVE +**.
- ② Enter profit margin rate, press **%** to obtain amount of markup.
- ③ Press **+** to obtain net price.
- ④ Enter 1, press **SAVE +**.
- ⑤ Enter discount rate, press **%** **-**.
- ⑥ Repeat Step ⑤ for each discount rate.
- ⑦ Press **÷** to obtain list price.

**Sample Case:** ABC Corporation has produced a valve costing \$2.26 to manufacture. They want a profit of 25% over production cost and are offering a trade discount to distributors of 30/15/15. Determine the following per unit amounts:

- Amount of Markup
- Net Price
- Dealer Discount Ratio
- List Price

Solution

**Enter:** 2.26 **SAVE +** 25 **%** → \$ **0.57** amount of markup  
**+** → \$ **2.83** net price  
 1 **SAVE +** 30 **%** **-** 15 **%** **-** 15 **%** **-** → \$ **0.51** dealer discount ratio (*net price/\$1 of list price*)  
**÷** → \$ **5.59** list price

### Cash Discounts

Cash discounts are offered to retailers by manufacturers/wholesalers as an incentive for prompt payment. Typical terms of payment would be 2/10, n/30. This means that the buyer is entitled to deduct 2% of the invoice amount if paid within 10 days. Otherwise, the net amount of invoice is due in 30 days. Another type of discount is termed "anticipation" where the buyer is entitled to the 2% discount plus an additional discount of a percentage of the invoice balance if paid within 60 days.

This calculation finds the standard and anticipated discounts, and the net invoice amount when discount rates (*terms*), amount of invoice, and dates of invoice and payment are known. Information is entered as follows:

- ① Enter invoice amount, press **SAVE +**.
- ② Enter standard discount rate, press **%** to obtain amount of discount.
- ③ Press **-** to obtain balance.
- ④ Enter anticipation discount rate, press **%**.
- ⑤ Enter days remaining, press **x**.
- ⑥ Enter number of days used as interest base (*either 360 or 365*), press **÷** to obtain the amount of anticipation discount.
- ⑦ Press **-** to obtain net invoice amount.

**Sample Case:** An invoice for \$600 is dated January 10, 1973 and is paid on January 20. Terms are specified as 2/10, n/60—anticipation allowance is 6%. Determine the following:

- Amount of 2/10 Discount
- Invoice Balance Remaining (*Net Difference*)
- Amount of Anticipation Discount
- Net Invoice Amount

Solution

| Enter:                              | See Displayed:                                     |
|-------------------------------------|--|
| 600 <b>SAVE</b> 2 <b>%</b>          | \$ <b>12.00</b> 2/10 discount                      |
| <b>-</b>                            | \$ <b>588.00</b> balance ( <i>net difference</i> ) |
| 6 <b>%</b> 50 <b>x</b> 360 <b>÷</b> | \$ <b>4.90</b> anticipation discount               |
| <b>-</b>                            | \$ <b>583.10</b> net invoice amount                |

## Statistical Analysis

### Mean, Standard Deviation

This calculation finds the mean (*arithmetic average*) and standard deviation (*measure of dispersion around the mean*). Options are provided to enable you to interact with and modify results by adding new data or correcting data entry errors. In addition, the number of entries and sum of the squares can be obtained. Information is entered as follows:

- ① **Press** **CLEAR** **CLx** to assure the HP-80 is clear of previous data.
- ② **Key** in values successively until all are entered; **press** **Σ+** after each entry.\* To correct an incorrect value before it is loaded with the **Σ+** keystroke, **press** **CLx**. After the value is loaded, correct by reentering incorrect value, **press** **Σ+**, enter correct value, **press** **Σ+**, and continue entering values. The last **Σ+** pressed provides the sum of all entries.
- ③ **Press** **Σx** to obtain mean.
- ④ **Press** **Σxy** to obtain standard deviation. If there are more values to be entered, go to step ②.
- ⑤ **Press** **Σxy** again.
- ⑥ **Press** **Σx**, go to step ②.

\*Data values must be keyed in manually prior to each **Σ+** keystroke; they cannot be generated through intermediate calculations or **RCL** operations.

The following option enables you to obtain the sum of squares and sum of entries, as well as the mean and standard deviation:

- ① Perform steps ①, ②, and ③ above.
- ② **Press** **R+** to obtain standard deviation (*steps ④ and ⑤ above are omitted*).
- ③ **Press** **R+** to obtain the sum of squares.
- ④ **Press** **R+** to obtain the number of entries. If there are more values to be entered, go to step ③ below.
- ⑤ **Press** **R+** again. Go to step ④ above.

**Sample Case 1:** In a recent survey to determine the average age of the 10 wealthiest people in the U.S., the following data were obtained:

62 84 47 58 68 60 62 59 71 73

Of the ages given, what is the mean; the standard deviation?

Solution

| Enter:   | See Displayed:                  |
|--|---------------------------------|
| <b>CLEAR</b> <b>CLx</b>  |                                 |
| 62 <b>Σ+</b> 84 <b>Σ+</b> 47 <b>Σ+</b> 58 <b>Σ+</b> 68 <b>Σ+</b> |                                 |
| 60 <b>Σ+</b> 62 <b>Σ+</b> 59 <b>Σ+</b> 71 <b>Σ+</b> 73 <b>Σ+</b> | <b>644.00</b> sum of numbers    |
| <b>Σx</b>  | <b>64.40</b> mean               |
| <b>Σxy</b>   | <b>10.10</b> standard deviation |

Add two more ages (87 and 49) after the initial calculation. What is the new mean and standard deviation?

| Enter:   | See Displayed:                      |
|--|-------------------------------------|
| <b>Σxy</b> <b>→Σ</b> <b>Σ+</b> 87 <b>Σ+</b> 49 <b>Σ+</b> | <b>780.00</b> new sum of numbers    |
| <b>Σx</b>  | <b>65.00</b> new mean               |
| <b>Σxy</b>   | <b>12.29</b> new standard deviation |

**Sample Case 2:** Perform error recovery after entering the second value in error.

Solution

**Enter:** CLEAR CLX  
 62 [Σ+] 44 [Σ+] 44 [Σ+] 84 [Σ+] 47 [Σ+] 58 [Σ+] 60 [Σ+] 60 [Σ+] 62 [Σ+] 59 [Σ+] 71 [Σ+] 73 [Σ+] → 644.00 sum of numbers  
 → 64.40 mean  
 → 10.10 standard deviation

See Displayed:

**Sample Case 3:** Find the sum of the squares and the number of entries in addition to the mean and standard deviation.

Solution

**Enter:** CLEAR CLX  
 62 [Σ+] 84 [Σ+] 47 [Σ+] 58 [Σ+] 68 [Σ+] 60 [Σ+] 62 [Σ+] 59 [Σ+] 71 [Σ+] 73 [Σ+] → 644.00 sum of numbers  
 → 64.40 mean  
 → 10.10 standard deviation  
 → 42392.00 sum of squares  
 → 10.00 number of entries

See Displayed:

### Linear Regression (Trend Line) Analysis

Linear regression techniques are used typically for projecting events based upon an extrapolation from a known trend. The formula uses the constant storage location, therefore, any value stored there will be destroyed when the final key (*the one that triggers the result*) is pressed. Input data must be evenly spaced and in chronological sequence. Figure 4 illustrates a trend line analysis. Information is entered as follows:

- 1 Press CLEAR CLX to clear machine of existing data.
- 2 Enter successive values, press TL after each; the entry sequence number is displayed after each entry.

- 3 After all data are entered (after last TL) press COMPUTE TL to obtain the so-called "y-intercept" value at point 0—the point at which the trend line, traveling the horizontal axis (time line), intersects the vertical axis (representing given units of quantity).
- 4 Enter number of time period (any time value), press n.
- 5 Press TL to obtain trend line value.
- 6 Repeat step 5 to obtain each successive trend value per time unit, or go back to step 4 to find the values for a unique time position.

**Note 1:** Time position can be seen at any time by pressing xzy key—be sure to press xzy again before resuming.

**Note 2:** The slope (change in units of quantity per time period) of the trend line may be found by pressing R+ R+.

**Sample Case:** Sales figures for a six month period are:

| Month | Sales (\$ in thousands) |
|-------|-------------------------|
| 1     | 476                     |
| 2     | 589                     |
| 3     | 570                     |
| 4     | 625                     |
| 5     | 619                     |
| 6     | 570                     |

Generate a linear trend forecast of the second six months' sales level based on the first six months' sales. How many entries are there? Find the theoretical forecast values for the second six months.

Solution

**Enter:** CLEAR CLX  
 476 TL 589 TL 570 TL 625 TL 619 TL  
 570 TL → 6.00 number of entries  
 COMPUTE TL → \$ 513.33 value of sales trend line at month 0  
 7 n TL → \$ 636.33 extrapolated sales at month 7  
 TL → \$ 653.90 extrapolated sales at month 8

See Displayed:

|    |   |    |        |                                |
|----|---|----|--------|--------------------------------|
| TL | → | \$ | 671.48 | extrapolated sales at month 9  |
| TL | → | \$ | 689.05 | extrapolated sales at month 10 |
| TL | → | \$ | 706.62 | extrapolated sales at month 11 |
| TL | → | \$ | 724.19 | extrapolated sales at month 12 |

If this trend continues as projected, what will be the percent growth for the year?

**Enter:**  
513.33 **SAVE** + 724.19 **%** → **See Displayed:**  
41.08 % growth for year

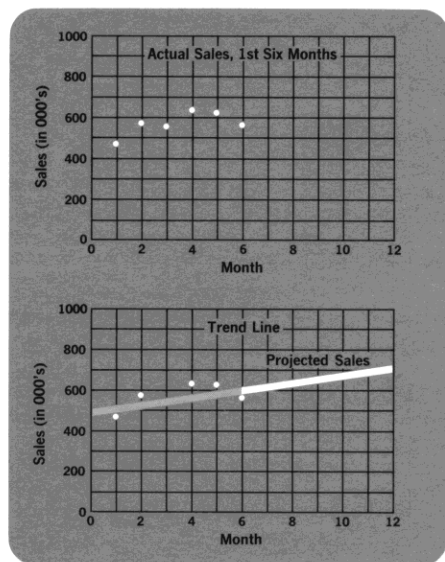


Figure 4. Example of Trend Line Analysis

## Denominate Number Conversion

Denominate numbers are used to express units of measure: length, weights, time, currencies, etc. The principles illustrated by the following examples of currency conversion can be extended to other types of unit conversion problems.

### U.S.-to-Foreign Currency Conversion

This calculation finds the value of U.S. dollars in terms of foreign currency when the prevailing foreign-to-U.S. currency exchange rate, and the amount of dollars to be converted are known. Information is entered as follows:

- ① **Enter** dollar amount to be converted, **press** **SAVE** +.
- ② **Enter** exchange rate, **press** **÷** to obtain equivalent amount of foreign currency.

**Sample Case:** If the rate of exchange is \$2.4010, what is \$30.20 worth in English currency?

**Solution**

**Enter:**  
30.20 **SAVE** + 2.4010 **÷** → **See Displayed:**  
12.58 £  
4 → 12.5781 £ (rounded to 4 decimal places)

### Foreign-to-U.S. Currency Conversion

This calculation finds the value of a foreign currency in terms of U.S. dollars when the prevailing foreign-to-U.S. currency exchange rate and amount to be converted are known. Information is entered as follows:

- ① **Enter** amount to be converted, **press** **SAVE** +.
- ② **Enter** exchange rate, **press** **x** to obtain equivalent amount of U.S. dollars.

**Sample Case:** Using the same exchange rate of \$2.4010, how much is 15.11 £ worth in U.S. money?

**Solution**

**Enter:**  
15.11 **SAVE** + 2.4010 **x** → **See Displayed:**  
\$36.28

# Appendix A

## Design Concepts

The HP-80 uses the most efficient way known to computer science for evaluating mathematical expressions: (1) the operational stack and (2) reverse "Polish" (*Lukasiewicz*) notation.

## Operational Stack

The four temporary memory locations (*number registers*)—arranged in the form of a "stack"—are called **X**, **Y**, **Z**, and **T**, respectively.

### Operational Stack

To avoid confusion between the name of a location and its contents, the location is designated by a capital letter and the contents by a small letter. Thus, **x**, **y**, **z** and **t** are the contents of **X**, **Y**, **Z**, and **T**.

| Contents | Location Name |
|----------|---------------|
| t        | T             |
| z        | Z             |
| y        | Y             |
| x        | X             |

**NOTE:** The contents of the **X** location are always displayed.

When you key in a number, it goes into the **X** location—the only location displayed. When you press **SAVE**  $\uparrow$ , this number is repeated into the **Y** location. At the same time, **y** is moved up to **Z** and **z** is moved up to **T** like this:

| Press                  | Contents | Location |
|------------------------|----------|----------|
| <b>SAVE</b> $\uparrow$ | t        | (Lost)   |
|                        | z        | T        |
|                        | y        | Z        |
|                        | x        | Y        |
|                        |          | X        |

When you press **+**, **x** is added to **y**, and the entire stack drops to display the answer in **X**. The same thing happens for **-**,  **$\times$**  and  **$\div$** . Whenever the stack drops, **t** is duplicated from **T** into **Z**, and **z** drops to **Y** as follows:

| Press   | Contents  | Location  |
|---|---|---|
| <b>+</b> , <b>-</b> ,<br><b><math>\times</math></b> or <b><math>\div</math></b> | <div> <div>t</div> <div>z</div> <div>y</div> <div>x</div> <div> <div>y + x</div> <div>y - x</div> <div>y <math>\times</math> x</div> <div>y / x</div> </div> </div> | <div>T</div> <div>Z</div> <div>Y</div> <div>X</div> |

Look at the contents of the stack as we calculate  $(3 \times 4) + (5 \times 6)$ . The keys used are shown above the circled steps ① through ⑨. Directly above the keys you see the information in **X**, **Y**, **Z** and **T** after the key stroke.

| T    |    |                        |    |                            |     |                        |    |                                     |
|------|----|------------------------|----|----------------------------|-----|------------------------|----|-------------------------------------|
| Z    |    |                        |    |                            | 12. | 12.                    |    |                                     |
| Y    |    | 3.                     | 3. |                            | 12. | 5.                     | 5. | 12.                                 |
| X    | 3. | 3.                     | 4. | 12.                        | 5.  | 5.                     | 6. | 30.                                 |
| KEY  | 3  | <b>SAVE</b> $\uparrow$ | 4  | <b><math>\times</math></b> | 5   | <b>SAVE</b> $\uparrow$ | 6  | <b><math>\times</math></b> <b>+</b> |
| STEP | ①  | ②                      | ③  | ④                          | ⑤   | ⑥                      | ⑦  | ⑧                                   |

### Step Remarks

- 3 is in display (**X**).
- 3 is duplicated into **Y**.
- 4 is in display (**X**).
- Contents of **X** and **Y** are multiplied; result (12) is loaded into **X**.
- Automatic **SAVE**  $\uparrow$  pushes 12 into **Y** when 5 is keyed in, display shows 5.
- SAVE**  $\uparrow$  pushes 12 into **Z**, 5 into **Y**, and leaves **X** unchanged.
- 6 in display overwrites 5 in **X** since it immediately follows **SAVE**  $\uparrow$ .
- Contents of **X** and **Y** are multiplied; result (30) is loaded into **X**, 12 drops to **Y**.
- Contents of **X** and **Y** are added; result (42) is loaded in **X**.

## Rearranging the Stack

The **R↓** (roll down) key lets you review the stack contents without losing data. It is also used to reposition data within the stack. Here is what happens each time you press **R↓**:

| Press     | Contents | Location |
|-----------|----------|----------|
| <b>R↓</b> |          |          |

**Example:** Load the stack by pressing: 1 **SAVE ↓** 2 **SAVE ↓** 3 **SAVE ↓** 4.  
(The stack now contains **x** = 4, **y** = 3, **z** = 2, and **t** = 1). To review the contents of the stack press **R↓** four times. The fourth **R↓** returns the stack to its original position (**x** = 4, **y** = 3, **z** = 2, and **t** = 1).

The **x↔y** key exchanges **x** and **y** as shown below.

| Press      | Contents | Location |
|------------|----------|----------|
| <b>x↔y</b> |          |          |

You will often find that **x** and **y** should be exchanged before a **÷**, **÷** or **y<sup>x</sup>** operation.

**Example:** Find 2<sup>9</sup>

| Press                | See    | Remarks                                   |
|----------------------|--------|---|
| 9                    | 9.     |   |
| <b>SAVE ↓</b>        | 9.00   |   |
| 2                    | 2.     | <b>x</b> and <b>y</b> are in wrong order. |
| <b>x↔y</b>           | 9.00   | <b>x</b> and <b>y</b> are in right order. |
| <b>y<sup>x</sup></b> | 512.00 |   |

## Appendix B

### Combined Arithmetic Processes

The HP-80 performs combined arithmetic operations—serial, mixed and chain calculations—with ease. If you read Appendix A (*Design Concepts*) you now know how the operational stack works and can apply that knowledge to the following examples.

### Automatic Doubling, Squaring

If you want to double or square a number, it's not necessary to press that number twice. Merely enter the number, save it and press **+** to double or **x** to square the number. For example, to double 3,

**Enter:** 3 **SAVE ↓** **+** **See Displayed:**

3 **SAVE ↓** **+** → 6.00 3 doubled

The following illustrates the data flow in the stack.

| Press         | See  | Remarks   |
|---------------|------|---|
| 3             | 3.   | 3 is keyed into <b>X</b> .  |
| <b>SAVE ↓</b> | 3.00 | 3 is loaded into <b>X</b> and <b>Y</b> .  |
| <b>+</b>      | 6.00 | Contents of <b>X</b> and <b>Y</b> are added; result (6) is loaded into <b>X</b> . |

To square 3,

**Enter:** 3 **SAVE ↓** **x** **See Displayed:**

3 **SAVE ↓** **x** → 9.00 3 squared

Again, in the stack,

| Press         | See  | Remarks  |
|---------------|------|--|
| 3             | 3.   | 3 is keyed into <b>X</b> .   |
| <b>SAVE ↓</b> | 3.00 | 3 is loaded into <b>X</b> and <b>Y</b> .   |
| <b>x</b>      | 9.00 | Contents of <b>X</b> and <b>Y</b> are multiplied and the product (9) is loaded into <b>X</b> . |

## Serial Calculation

Any time a new number is entered after any calculation, the HP-80 performs an automatic **SAVE +** on the result of the calculation. This feature permits a serial calculation that has intermediate results to which a series of new values can be applied without your having to write down or store any of the intermediate results. For example: to find the sum of 4, 6, 8 and 10,

| Enter:          |            | See Displayed: |
|-----------------|------------|----------------|
| 4 <b>SAVE +</b> | 6 <b>+</b> | <b>10.00</b>   |
| 8 <b>+</b>      |            | <b>18.00</b>   |
| 10 <b>+</b>     |            | <b>28.00</b>   |

The same principle applies to serial multiplication, division and subtraction, too. And in the stack,

| Press         | See   | Remarks  |
|---------------|-------|--|
| 4             | 4.    | 4 is keyed into <b>X</b> .   |
| <b>SAVE +</b> | 4.00  | 4 is loaded into <b>X</b> and <b>Y</b> .   |
| 6             | 6.    | 6 is keyed and loaded into <b>X</b> ; current contents (4) are destroyed.  |
| <b>+</b>      | 10.00 | Contents of <b>X</b> (6) and <b>Y</b> (4) are added then contents are destroyed; result (10) is loaded into <b>X</b> .   |
| 8             | 8.    | 8 is keyed and loaded into <b>X</b> , 10 is loaded into <b>Y</b> .   |
| <b>+</b>      | 18.00 | Contents of <b>X</b> (8) and <b>Y</b> (10) are added then contents are destroyed; result (18) is loaded into <b>X</b> .  |
| 10            | 10.   | 10 is keyed and loaded into <b>X</b> , 18 is loaded into <b>Y</b> .  |
| <b>+</b>      | 28.00 | Contents of <b>X</b> (10) and <b>Y</b> (18) are added then contents are destroyed; result (28) is loaded into <b>X</b> . |

## Chained Calculation

Chained calculations can be used to find the sums of products (*adding the results of two or more multiplication operations*) or the product of sums (*multiplying the results of two or more addition operations*). For example, if you sold 12 items at \$1.58 each, 8 items at \$2.67 each and 16 items at \$0.54 each, the total sale price is:

$$(12 \times 1.58) + (8 \times 2.67) + (16 \times 0.54)$$

With ordinary calculators you have to make two passes for this type of problem by first calculating the items in parentheses and then adding

the results. With the HP-80 you can do this in one pass without having to write down or store intermediate results. To do so,

| Enter:           |               | See Displayed:  |
|------------------|---------------|-----------------|
| 12 <b>SAVE +</b> | 1.58 <b>X</b> | <b>\$ 18.96</b> |
| 8 <b>SAVE +</b>  | 2.67 <b>X</b> | <b>\$ 21.36</b> |
| <b>+</b>         |               | <b>\$ 40.32</b> |
| 16 <b>SAVE +</b> | .54 <b>X</b>  | <b>\$ 8.64</b>  |
| <b>+</b>         |               | <b>\$ 48.96</b> |

Back at the stack,

| Press         | See   | Remarks   |
|---------------|-------|---|
| 12            | 12.   | 12 is keyed into <b>X</b> .   |
| <b>SAVE +</b> | 12.00 | 12 is loaded into <b>X</b> and <b>Y</b> .   |
| 1.58          | 1.58  | 1.58 is keyed and loaded into <b>X</b> ; previous contents (12) are destroyed.  |
| <b>X</b>      | 18.96 | Contents of <b>X</b> (1.58) and <b>Y</b> (12) are multiplied then contents are destroyed; result (18.96) is loaded into <b>X</b> .  |
| 8             | 8.    | 8 is keyed into <b>X</b> , 18.96 is loaded into <b>Y</b> .  |
| <b>SAVE +</b> | 8.00  | 8 is loaded into <b>X</b> and <b>Y</b> , 18.96 is loaded into <b>Z</b> .  |
| 2.67          | 2.67  | 2.67 is keyed in and loaded into <b>X</b> ; previous contents (8) are destroyed.  |
| <b>X</b>      | 21.36 | Contents of <b>X</b> (2.67) and <b>Y</b> (8) are multiplied then contents are destroyed; result (21.36) is loaded into <b>X</b> , 18.96 is dropped from <b>Z</b> to <b>Y</b> .          |
| <b>+</b>      | 40.32 | Contents of <b>X</b> (21.36) and <b>Y</b> (18.96) are added then contents are destroyed; result (40.32) is loaded into <b>X</b> .   |
| 16            | 16.   | 16 is keyed into <b>X</b> , 40.32 is loaded into <b>Y</b> .   |
| <b>SAVE +</b> | 16.00 | 16 is loaded into <b>X</b> and <b>Y</b> , 40.32 is loaded into <b>Z</b> .   |
| .54           | .54   | .54 is keyed in and loaded into <b>X</b> ; previous contents (16) are destroyed.  |
| <b>X</b>      | 8.64  | Contents of <b>X</b> (.54) and <b>Y</b> (16) are multiplied then contents are destroyed; result (8.64) is loaded into <b>X</b> , contents of <b>Z</b> (40.32) are dropped to <b>Y</b> . |
| <b>+</b>      | 48.96 | Contents of <b>X</b> (8.64) and <b>Y</b> (40.32) are added then contents are destroyed; result (48.96) is loaded into <b>X</b> .  |

## Mixed Chain Calculation

Obviously, chain calculations can use any arithmetic operator—add and subtract as well as multiply and divide. In addition, a problem may be calculated with any combination of arithmetic operators in both nested and linked operations. For example, to calculate

$$((12 \times 5) - 2) + ((8 \div 2) + 10) \times (213.08 \times 5 \div 1.33) \div 2$$

Enter:

See Displayed:

|        |          |   |          |
|--------|----------|---|----------|
| 12     | SAVE + 5 | X | 60.00    |
| 2      | -        |   | 58.00    |
| 8      | SAVE + 2 | ÷ | 4.00     |
| 10     | +        |   | 14.00    |
|        | +        |   | 72.00    |
| 213.08 | SAVE + 5 | X | 1065.40  |
| 1.33   | ÷        |   | 801.05   |
|        | X        |   | 57675.79 |
| 2      | ÷        |   | 28837.89 |

Review the stack:

| Press  | See   | Remarks  |
|--------|-------|--|
| 12     | 12.   | 12 is keyed into <b>X</b> .  |
| SAVE + | 12.00 | 12 is loaded into <b>X</b> and <b>Y</b> .  |
| 5      | 5.    | 5 is keyed and loaded into <b>X</b> ; previous contents (12) are destroyed.  |
| X      | 60.00 | Contents of <b>X</b> (5) and <b>Y</b> (12) are multiplied then contents are destroyed; result (60) is loaded into <b>X</b> .   |
| 2      | 2.    | 2 is keyed and loaded into <b>X</b> , 60 is loaded into <b>Y</b> .   |
| -      | 58.00 | Contents of <b>X</b> (2) are subtracted from contents of <b>Y</b> (60) then contents are destroyed; result (58) is loaded into <b>X</b> .  |
| 8      | 8.    | 8 is keyed into <b>X</b> , 58 is loaded into <b>Y</b> .  |
| SAVE + | 8.00  | 8 is loaded into <b>X</b> and <b>Y</b> , 58 is loaded into <b>Z</b> .  |
| 2      | 2.    | 2 is keyed and loaded into <b>X</b> ; previous contents (8) are destroyed.   |
| ÷      | 4.00  | Contents of <b>Y</b> (8) are divided by contents of <b>X</b> (2) then contents are destroyed; result (4) is loaded into <b>X</b> ; contents of <b>Z</b> (58) are dropped to <b>Y</b> . |

| Press  | See      | Remarks  |
|--------|----------|--|
| 10     | 10.      | 10 is keyed and loaded into <b>X</b> ; 4 is loaded into <b>Y</b> ; 58 is loaded into <b>Z</b> .  |
| +      | 14.00    | Contents of <b>X</b> (10) and <b>Y</b> (4) are added then contents are destroyed; result (14) is loaded into <b>X</b> ; contents of <b>Z</b> (58) are dropped to <b>Y</b> .                          |
| +      | 72.00    | Contents of <b>X</b> (14) and <b>Y</b> (58) are added then contents are destroyed; result (72) is loaded into <b>X</b> .   |
| 213.08 | 213.08   | 213.08 is keyed into <b>X</b> , 72 is loaded into <b>Y</b> .   |
| SAVE + | 213.08   | 213.08 is loaded into <b>X</b> and <b>Y</b> , 72 is loaded into <b>Z</b> .   |
| 5      | 5.       | 5 is keyed and loaded into <b>X</b> ; previous contents (213.08) are destroyed.  |
| X      | 1065.40  | Contents of <b>X</b> (5) and <b>Y</b> (213.08) are multiplied then contents are destroyed; result (1065.40) is loaded into <b>X</b> , contents of <b>Z</b> (72) are dropped to <b>Y</b> .            |
| 1.33   | 1.33     | 1.33 is keyed and loaded into <b>X</b> ; 1065.40 is loaded into <b>Y</b> ; 72 is loaded into <b>Z</b> .  |
| ÷      | 801.05   | Contents of <b>Y</b> (1065.40) are divided by contents of <b>X</b> (1.33) then contents are destroyed; result (801.05) is loaded into <b>X</b> ; contents of <b>Z</b> (72) are dropped to <b>Y</b> . |
| X      | 57675.79 | Contents of <b>X</b> (801.05) and <b>Y</b> (72) are multiplied then contents are destroyed; result (57675.79) is loaded into <b>X</b> .  |
| 2      | 2.       | 2 is keyed and loaded into <b>X</b> , 57675.79 is loaded into <b>Y</b> .   |
| ÷      | 28837.89 | Contents of <b>Y</b> (57675.79) are divided by contents of <b>X</b> (2) then contents are destroyed; result (28837.89) is loaded into <b>X</b> .   |

## Appendix C

### Extended Bond Calculations

#### Computing Time to Maturity

(Using Traditional Trade Custom)

Time to maturity for calculation of basis prices is computed in years, months and days. The time from settlement date to the next coupon date is always the remainder of the coupon period after calculation of time for accrued interest. For example, if accrued interest is for 3 months and 17 days, time to the next coupon date would be 2 months, 13 days.

In computing time to maturity, the 31st of a month is always considered the same as the first of the following month. For example, if the settlement date is 11/15/72 and maturity is on 1/1/81, the time to maturity is 8 years, 1 month and 15 days.

#### Calculation of Time for Accrued Interest

Accrued interest on bonds is to be added to principal—computed for elapsed months and days on a 360-day year basis. In this computation a month is considered to be 1/12th of 360 days, or 30 days, and each period from a date in one month to the same date in the following month shall be considered to be 30 days. In the calculation, the first day of the accrual period should be counted, and the last or settlement date omitted.

The number of elapsed days should be computed in accordance with the examples given below:

- 1st to the 30th of the same month is figured as 29 days
- 1st to the 31st of the same month is figured as 30 days
- 1st to the 1st of the following month is figured as 30 days
- 1st to the 28th of February is figured as 27 days

Where interest is payable on the 30th or 31st of the month:

- 30th or 31st to the 1st of the following month is figured as 1 day
- 30th or 31st to the 30th of the following month is figured as 30 days
- 30th or 31st to the 31st of the following month is figured as 30 days

#### Calculation of Accrued Interest

To calculate accrued interest:

- ① Determine the number of months and days between settlement and the last coupon date.
- ② Multiply the number of months by 30 and add the result to the number of days.
- ③ Calculate the accrued interest; use the total number of days (*above*) as time, the coupon rate as the interest, and the par value (*in dollars*) as the principal.

**Example:** What is the accrued interest on a  $5\frac{3}{4}\%$  bond, having a par value of \$1000, and maturing on July 15, 2001? The settlement date is September 11, 1971. Accrued interest is for 1 month, 26 days or a total of 56 days.

Solution

**Enter:**  
56  $\square$  n 5.75  $\square$  i 1000  $\square$  PV  $\square$  <sup>INTR</sup> PMT  $\rightarrow$  **See Displayed:**  
\$8.94 accrued interest

#### Callable Bonds

Some bonds are redeemed prior to their stated maturity date and, in most cases, an incentive is provided for the holder of such bonds. This incentive is known as a call premium; it is merely a sum of money to be paid in the future if the bond is called.

The general procedure for determining a callable value is as follows:

- ① Determine bond price as usual.
- ② Find the present value of the *premium only* over the number of coupon periods; use the effective yield rate *per period* for the calculation.
- ③ Add the present value of the premium to the price of the bond.

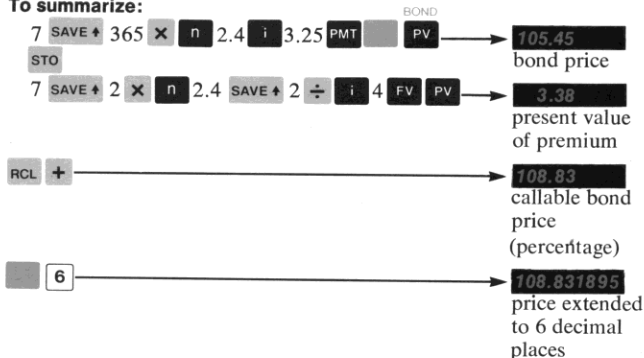
**Example:** Find the value of a 3.25% bond to yield 2.40% on assumption of call at 104 in 7 years.

- ① **Key in 7 (yrs), press**  $\square$  <sup>SAVE</sup>  $\square$ .
- ② **Key in 365 (days/yr), press**  $\square$   $\times$   $\square$  n  $\square$ .
- ③ **Key in 2.4 (yield), press**  $\square$  i  $\square$ .
- ④ **Key in 3.25 (coupon), press**  $\square$  <sup>BOND</sup> PMT  $\square$ .
- ⑤ **Press**  $\square$   $\square$  <sup>PV</sup>  $\square$  to obtain percentage price, (105.45).
- ⑥ **Press**  $\square$  <sup>STO</sup>  $\square$  to store in constant storage location.

You have just found the price of the bond and have stored it temporarily. Now, determine the present value of the call premium:

- ① **Key** in 7 (yrs.), **press** **SAVE**.
- ② **Key** in 2 (coupons/yr.), **press** **X** **n**.
- ③ **Key** in 2.4 (yield), **press** **SAVE**.
- ④ **Key** in 2 (coupons/yr.), **press** **÷** **i**.
- ⑤ **Key** in 4 (call premium), **press** **FV**.
- ⑥ **Press** **PV** to obtain present value of the premium, (3.38).
- ⑦ **Press** **RCL** **+** to add bond price and to obtain desired callable price, (108.83).
- ⑧ **Press** **6** to show results rounded to six decimal places, (108.831895).

#### To summarize:



## Yield-to-Call Calculations

Effective annual yield-to-call calculations are made in the same manner as yield-to-maturity calculations except that the annual coupon rate and the price must be divided by the ratio of the call price-to-par before being loaded into their appropriate locations. To accomplish this, it is first necessary to store the current bond price into constant storage.

The general procedure for determining yield-to-call is as follows:

- ① Store the current bond price in constant storage.
- ② Determine the time portion of the yield problem as usual.
- ③ Divide the annual coupon rate by the call price-to-par ratio before loading it into **PMT**.
- ④ Recall the current price from constant storage and divide it also by the call price-to-par ratio, then load into **PV**.
- ⑤ Find the yield-to-call by pressing **YTM**.

**Example:** Find the yield-to-call of a 3.25% bond callable at 104 in 7 years now selling at 108.831895.

- ① **Key** in 108.831895 (current price), **press** **STO**.
- ② **Key** in 7 (yrs.), **press** **SAVE**.
- ③ **Key** in 365 (days/yr.), **press** **X** **n**.
- ④ **Key** in 3.25 (coupon), **press** **SAVE**.
- ⑤ **Key** in 1.04 (call price-to-par ratio), **press** **÷** **PMT**.
- ⑥ To recall current price, **press** **RCL**.
- ⑦ **Key** in 1.04 (call price-to-par ratio), **press** **÷** **PV**.
- ⑧ **Press** **YTM** to obtain yield, (2.40%).

#### To summarize:



## Bond Amortization

Amortization of a bond premium is the gradual "writing down" of a bond investment until it reaches its face value at maturity. Conversely, for a discount bond the value is gradually "written up" until it reaches face value at maturity. The proper amortization involves the use of the same effective income ratio throughout the entire life of the bond.

The general steps to be followed are:

- ① Determine the effective yield-to-maturity of the bond as of the purchase date.
- ② Find the amortized value by simply applying the computed yield for the remaining time to maturity.

**Example:** A 4% bond was purchased at 106.75 when its time to maturity was 9 years and 10 months. What is the amortized value of the bond when it has 8 years and 11 months to maturity?

- ① Key in 10 (mo.), press **SAVE ↑**.
- ② Key in 12 (mo./yr.), press **÷**.
- ③ Key in 9 (yrs.), press **+**.
- ④ Key in 365 (days/yr.), press **×** **n**.
- ⑤ Key in 4 (coupon rate), press **PMT**.
- ⑥ Key in 106.75 (price), press **PV**.
- ⑦ Press **YTM** **i** to get yield (3.19).

At this point the effective yield-to-maturity has been calculated and need only be applied to the remaining time to maturity to arrive at the correct amortized value, as follows:

- ① Key in 11 (mo.), press **SAVE ↑**.
- ② Key in 12 (mo./yr.), press **÷**.
- ③ Key in 8 (yrs.), press **+**.
- ④ Key in 365 (day/yr.), press **×** **n**.
- ⑤ Key in 3.19 (computed YTM), press **i**.
- ⑥ Key in 4 (coupon), press **PMT**.
- ⑦ Press **BOND** **PV** to obtain the amortized value (106.24).
- ⑧ Press **6** to obtain answer rounded to six decimal places (106.241026).

#### To summarize:

10 **SAVE ↑** 12 **÷** 9 **+** 365 **×** **n** 4 **PMT**  
 106.75 **PV** **YTM** **i** → **3.19** yield-to-maturity  
 11 **SAVE ↑** 12 **÷** 8 **+** 365 **×** **n** 3.19 **i**  
 4 **PMT** **BOND** **PV** → **106.24** amortized value  
**6** → **106.241026** value extended to 6 decimal places

## Implications of Increased Precision on Bond Calculations

The ability of the HP-80 to provide more accurate bond calculations can be directly translated into dollars and cents. This is especially true when buyers and sellers of bonds wish to evaluate a potential trade with respect to an alternate investment vehicle.

**Example:** Should you buy a 4% bond quoted at 97.010, to mature on October 15, 1973, and to settle on January 3, 1973?

#### Solution

First, calculate the yield-to-maturity according to the traditional method:

- ① Key in 12 (days), press **SAVE ↑**.
- ② Key in 30 (days/mo.), press **÷**.
- ③ Key in 9 (mo.), press **+**.
- ④ Key in 12 (mo./yr.), press **÷**.
- ⑤ Key in 365 (days/yr.), press **×** **n**.
- ⑥ Key in 4 (annual coupon rate), press **PMT**.
- ⑦ Key in 97.010 (bond price), press **PV**.
- ⑧ Press **YTM** **i** to obtain yield ( 8.00% ).

Next, calculate the actual price using the effective yield of 8.00% just calculated:

- ① Key in 1.031973 (settlement date), press **SAVE ↑**.
- ② Key in 10.151973 (maturity date), press **DAY**.
- ③ Key in 8.00 (calculated yield), press **i**.
- ④ Key in 4 (annual coupon rate), press **PMT**.
- ⑤ Press **BOND** **PV** to obtain actual price ( 97.02 ).

#### To summarize:

12 **SAVE ↑** 30 **÷** 9 **+** 12 **÷** 365 **×** **n** 4 **PMT**  
 97.010 **PV** **YTM** **i** → **8.00** %  
 yield by conventional method  
 1.031973 **SAVE ↑** 10.151973 **DAY** 8 **i** 4 **PMT**  
**BOND** **PV** → **97.02**  
 actual price

Thus, the actual price is 97.02, instead of the quoted 97.01, when you apply a conventionally calculated yield to a calculation using a more precise method. Therefore, it is to your advantage to buy this bond.

Another area of concern to investors is the accurate calculation of an *after-tax* yield (either to maturity or some other price). The procedure is to treat your exit (or sale) price the same as you would the call price in a yield-to-call calculation.

**Example:** You can buy a 3% bond on November 1, 1972 for 70 and expect to sell it in 5 years for 90. What is your net (*after-tax*) yield over the 5-year period if interim coupon payments are tax-free and your tax bracket is 50%?

**Solution**

First, determine what your *after-tax* proceeds on the bond will be after the 5 years:

$$\text{Capital gains} = 90 - 70 = 20$$

$$\text{Tax on capital gains} = 25\% \text{ of } 20 = 5$$

$$\text{Thus, net proceeds from bond} = 90 - 5 = 85$$

Now simply solve for yield using .85 (85/100) as the net price-to-par ratio, as follows:

- ① Key in 70 (purchase price), press **STO**.
- ② Key in 11.011972 (purchase date), press **SAVE +**.
- ③ Key 11.011977 (assumed sell date), press **DAY**.
- ④ Key in 3 (annual coupon rate), press **SAVE +**.
- ⑤ Key in .85 (net price-to-par ratio), press **÷** **PMT**.
- ⑥ Recall 70 (purchase price) by pressing **RCL**.
- ⑦ Key in .85 (net price-to-par ratio), press **÷** **PV**.
- ⑧ Press **YTM** **i** to obtain after-tax yield (7.87%).

**To summarize:**

70 **STO** 11.011972 **SAVE +** 11.011977 **DAY** 3 **SAVE +** .85 **÷** **PMT**  
**RCL** .85 **÷** **PV** **YTM** **i** → 7.87 % yield after taxes

## Appendix D

### Operating Characteristics

#### Operating Limits

##### Accuracy

Accuracy of the HP-80 varies according to the operation being performed.

Arithmetic operations (+, −, ×, ÷) are accurate to 10 digits ± 1 count; that is, the value of the 10th digit could be 1 less or 1 more than the value displayed.

Special operations solved through an iterative method ( **YTM** **i** ) and ( **i** ) \* use numerical analysis techniques formerly requiring computers or large-scale programmable calculators. These operations are accurate to 5 digits.

The  $y^*$  function (which is used in the top row financial operations) produces an answer corresponding to *some*  $x$  within ±7 counts in the tenth least significant digit of the input  $x$ , and *some*  $y$  within ±4 counts in the tenth least significant digit of the input  $y$ .

##### Execution Time

Execution time for iterative solutions varies according to the numbers you enter. For example, in certain interest rate calculations the solution time is related to the ratio  $PV/(PMT \times n)$  or  $FV/(PMT \times n)$ . Extreme cases outside those normally encountered may require minutes.

##### Range

Financial calculations using the top row of keys are not permitted for interest rate values very close or equal to 0; specifically, rates between  $i = -0.0000001\%$  and  $i = +0.0000001\%$  are not handled.

##### Error Indicators

###### Range Errors

Any computation or data entry resulting in a magnitude greater than or equal to  $10^{99}$ , or less than  $10^{-99}$ , triggers an error signal indicated by a blinking display.

\*Bond yield calculations may result in slightly reduced accuracy if the problem is an unusual case such as calculating a 50% yield-to-maturity for a 2% bond. For example, the yield-to-maturity on a 2% bond, maturing in 3 years, 3 months and selling at 26.481133 is 50.00%. The answer displayed is 49.99%. The formula for determining error magnitude is: percent calculation error for bond yield  $\leq 2 \times \text{yield (actual)} \times \text{coupon} \times 10^{-4}$ . The operating limits for the bond yield algorithm are defined such that the price of the bond must be above 20 and below 5,000, and coupon must be greater than  $\frac{1}{4}\%$  and less than the price of the bond (expressed as a percent of par).

## Logical Errors

If you attempt a calculation containing a logical error—say division by zero—an error signal is triggered and a blinking display appears. To reset, press **CLX**. The following are examples of logical errors:

- Division by zero
- $y^x$ , where  $y \leq 0$
- Date/day calculations where (a) the range is exceeded, (b) a date entered doesn't exist, (c) date entry conventions are not followed

## Scientific Notation

Answers greater than  $10^{10}$  ( $9,999,999,999 + 1$ ) are displayed in scientific notation—an abbreviated form of the number showing an exponent of 10 in the last two character positions.

If a number is displayed in scientific notation and has a negative exponent, pressing **CHS** will, in addition to changing the sign of the number, alter the display of the exponent. Although the exponent is not displayed properly, it is correct internally and the number in the display may be used in a normal manner for further calculations. However, if you wish, you can produce the correct display before proceeding by pressing **x $\div$ y** **x $\div$ y**.

## Environmental Considerations

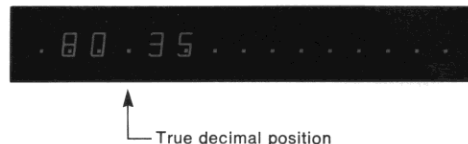
| Mode      | Temperature °C | Temperature °F   |
|-----------|----------------|------------------|
| Operating | 0°C to +50°C   | (32°F to 122°F)  |
| Charging  | +10°C to +40°C | (50°F to 104°F)  |
| Storage   | -40°C to +55°C | (-40°F to 131°F) |

## Battery Operation

Use only the HP Rechargeable Battery Pack, Model 82001A, which has been tested and is warranted for one year. The battery provides three to five hours of continuous operation. By turning off the power when the calculator is not in use, the HP-80 battery power will last easily throughout a normal working day. Note that it is normal for the battery charger to be warm to the touch when in use.

All decimal points light in the display when 2 to 5 minutes of operation time remain in the battery pack. Even when all decimal points are turned on, the true decimal position is known because an entire digit position is allocated to it.

## Example:



Operating the calculator for more than 2 to 5 minutes after this low power indication first occurs may result in calculation errors. The battery pack must be recharged by connecting the HP-80 to its battery charger (HP Model 82002A).

## Recharging and AC Line Operation

The HP-80 should be turned off before plugging in the charger. It can be turned on again after the charger is plugged into the power outlet and can be used during the charging cycle. *The HP-80 can be operated continuously from the ac line if desired.* There is no danger of overcharging the battery.

After 14 hours, a completely discharged battery will be fully charged. Shorter charge periods will allow reduced battery operating time. For convenience, overnight charging is recommended.

### CAUTION

To prevent damage to the calculator, the position of the line voltage select switch on the battery charger must be set to the proper line voltage.

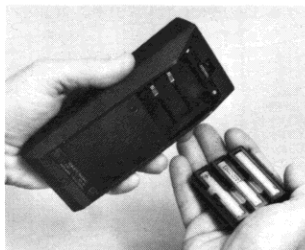
- ① Turn the HP-80 power switch to **OFF**.
- ② Insert battery charger plug into the rear connector of the HP-80 and insert power plug of battery charger into the power outlet. **The HP-80 will not operate when connected to the recharger unless the recharger is connected to a live power outlet.**
- ③ Slide the power switch to **ON**, see that 0.00 is displayed.
- ④ Slide power switch to **OFF** if you don't want to use the calculator while it is charging.
- ⑤ At end of the charging period, you may continue using your HP-80 with ac power or proceed to next step for battery operation.
- ⑥ With the power switch at **OFF**, disconnect battery charger from power receptacle and the battery charger from HP-80.

Temporary degradation, peculiar to nickel-cadmium batteries, may cause a decrease in the operating period of the battery pack. Should this happen turn the HP-80 on for at least five hours to discharge the batteries completely. Then put it on charge for at least 14 hours. This should correct the temporary degradation.

If the battery pack won't hold a charge, it may be defective. If the warranty is in effect, return the pack to Hewlett-Packard according to the instructions on page 74. If the battery pack is out of warranty, use the Accessory Order Card provided with your HP-80, to order a new battery pack. **Remember, you can use your HP-80 on ac power until the replacement battery pack arrives.**

### Battery Pack Replacement

1. Turn power switch to **OFF** and disconnect the battery charger.
2. Slide the two battery-door latches (*the top feet*) toward middle of calculator.

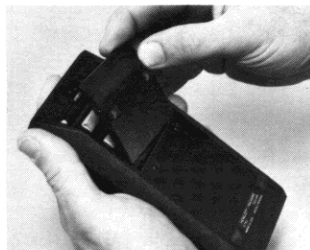


3. Let battery door and battery-pack fall into palm of hand.



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

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



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



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

**NOTE:** If you use your HP-80 extensively in field work or during travel, you may want to order the Model 82004A Battery Holder and Pack, consisting of battery charging attachment and spare battery pack. This enables you to charge one pack while using the other.

### CAUTION

Do not try to burn old batteries. They may **EXPLODE!**

## Appendix E

### Accessories

Standard and optional accessories for the HP-80 can be ordered by completing and mailing the Order Card provided. We will send you additional order cards as new optional accessories are added to our product line.

| Standard Accessories                   | Model/Part No.     |
|--|--------------------|
| <b>HP-80 Quick Reference Guide</b>     | <b>00080-90003</b> |
| <b>Battery Pack</b>                    | <b>82001A</b>      |
| <b>Battery Charger/AC Adapter</b>      | <b>82002A</b>      |
| <b>HP-80 Deluxe Travel Safety Case</b> | <b>82014A</b>      |
| <b>Soft Carrying Case</b>              | <b>82012A</b>      |
| <b>HP-80 Owner's Handbook</b>          | <b>00080-90001</b> |
| <b>Personalizing Labels (4 each)</b>   | <b>7120-2946</b>   |
| Optional Accessories                   | Model/Part No.     |
| <b>Battery Holder and Pack</b>         | <b>82004A</b>      |
| <b>Security Cradle</b>                 | <b>82007A</b>      |
| <b>Hard Leather Field Case</b>         | <b>82006A</b>      |

## Appendix F

### Service and Warranty

#### Servicing

##### Low Power

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

- Operate from ac power
- Charge the battery pack
- Insert a fully charged battery pack

##### Blank Display

If the display blanks out, turn the HP-80 off then on. If 0.00 does not appear on the display, check the following:

1. If battery charger is attached to HP-80, make sure it is plugged into outlet.
2. Examine battery pack to see if it is discharged or is not making contact.
3. If display is still blank, try operating the HP-80 from the ac line.
4. If display is still blank, the HP-80 is defective (*see warranty section*).

#### Warranty

##### In Warranty

The HP-80 is warranted against defects in materials and workmanship for one year from date of delivery. During the warranty period we will repair or replace components that prove to be defective, provided they are returned to Hewlett-Packard according to instructions (*see Shipping Instructions*). No other warranty is expressed or implied. We are not liable for consequential damage.

##### Out of Warranty

Beyond the one year warranty period, your calculator will be repaired for a moderate charge. Return the HP-80 along with all standard accessories (*see Shipping Instructions*). If only the battery pack is defective, simply order a replacement on the Order Card provided.

## Shipping Instructions

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

- Your HP-80 with all standard accessories in their travel safety case
- A completed Service Card (*from back cover pocket of this manual*)

If a battery pack is defective and within warranty, return the following to us:

- Only the defective battery pack
- A completed Service Card (*from back cover pocket of this manual*)

Send returned items safely packaged to the address shown on the Service Card.

Under normal conditions, your calculator will be repaired and re-shipped within two days of receipt at this address. Should other problems or questions arise regarding service, please call this telephone number: (408) 996-0100, and ask for **Advanced Products Customer Service**.

## Appendix G

### HP-80 Calculation Formulas

Unless otherwise stated:

- n = number of time periods
- i = periodic interest rate expressed as a decimal
- PMT = payment or deposit
- PV = present value or principal
- FV = future value
- I = interest amount

### Compound Interest

$$FV = PV (1 + i)^n$$

### Annuity

#### Loans

$$PV = PMT \left[ \frac{1 - (1 + i)^{-n}}{i} \right]$$

#### Savings

$$FV = PMT \left[ \frac{(1 + i)^n - 1}{i} \right]$$

### Add on Interest Rate to Annual Percentage Rate

r = decimal Add on rate

$$\frac{\frac{n}{1 + \frac{n}{12} r}}{1 + \frac{n}{12} r} = \frac{1 - (1 + i)^{-n}}{i}$$

APR = 1200i Where i is the solution for the above equation.

### Bond Calculations

n = total number of days between purchase and maturity  
INTR = decimal coupon rate (on annual basis)  
YTM = annual yield to maturity in decimal  
Bond = bond price

If n < 182.5

$$\text{Bond} = \frac{200 + 100 \text{ INTR}}{2 + \frac{n}{180} \cdot \text{YTM}} - \left( 1 - \frac{n}{180} \right) \frac{100 \text{ INTR}}{2}$$

If  $n > 182.5$

$$\text{Bond} = 100 \left( 1 + \frac{\text{YTM}}{2} \right)^{-\frac{n}{182.5}} + 100 \left( \frac{\text{INTR}}{\text{YTM}} \right) \times \left\{ \left( 1 + \frac{\text{YTM}}{2} \right)^j - \left( 1 + \frac{\text{YTM}}{2} \right)^{-\frac{n}{182.5}} \right\} - \frac{100 \text{ INTR} \cdot j}{2}$$

where  $j = 1 - \text{fractional part of } \frac{n}{182.5}$

(fractional part means that part to the right of the decimal point)

## Accumulated Interest

Interest paid between payment  $j$  to payment  $k$

$$I_{j \rightarrow k} = \text{PMT} \left[ k \cdot j - \frac{(1+i)^{k-n}}{i} \left[ 1 - (1+i)^{j-k} \right] \right]$$

Remaining balance to be paid at payment  $k$  ( $k = 1, 2, 3, \dots$ )

$$\text{PV}_k = \frac{\text{PMT}}{i} \left[ 1 - (1+i)^{k-n} \right]$$

## Rebate (Rule of 78's)

PV = finance charge

$$I_k = \frac{2(n-k+1)}{n(n+1)} \text{PV}$$

$I_k$  = interest charged at month  $k$

$$\text{Rebate} = \frac{(n-k)I_k}{2}$$

## Sum of Digits Depreciation

$D_k$  = depreciation at  $k$  ( $k = 1, 2, 3, \dots$ )

$$D_k = \frac{2(n-k+1)}{n(n+1)}$$

$BV_k$  = book value at  $k$

$$BV_k = (n-k) D_k / 2$$

## Percentage

$$\text{Percentage} = \text{base} \times \frac{\text{Rate}}{100}$$

$$\text{Percent Difference} = \Delta\% = \frac{\text{New Amount} - \text{Base}}{\text{Base}} \times 100$$

## Discounted Cash Flow Analysis

$PV_o$  = original investment

$PV_k$  = cash flow of  $k^{\text{th}}$  period

$i$  = decimal discount rate per period

$NPV_k$  = net present value at  $k$

$$NPV_k = -PV_o + \sum_{k=1}^n \frac{PV_k}{(1+i)^k}$$

## Notes

### Accrued Interest (simple interest)

$n$  = total number of days

$i$  = decimal interest on annual basis

$D$  = discount amount

Yield = decimal effective interest on discounted note

$$I_{360} = \frac{n}{360} \cdot PV \cdot i$$

$$I_{365} = I_{360} \times \frac{360}{365}$$

## Discounted notes

$$D_{360} = \frac{n}{360} \cdot FV \cdot i$$

$$D_{365} = D_{360} \times \frac{360}{365}$$

$$\text{Yield}_{360} = \frac{D_{360} \times 36000}{n(FV - D_{360})}$$

$$\text{Yield}_{365} = \text{Yield}_{360} \times \frac{360}{365}$$

## Trend Line

$S$  = slope

$Y_o$  = intercept at time zero

$k$  = time periods ( $k = 1, 2, 3, \dots$ )

$y_k$  = value at time  $k$

$N$  = total number of data points

$$= \frac{D_{365} \times 36500}{n(FV - D_{365})}$$

$$S = \frac{6}{N(N^2 - 1)} \left[ 2 \sum_{k=1}^N ky_k - (N+1) \sum_{k=1}^N Y_k \right]$$

$$Y_o = \frac{1}{N} \sum_{k=1}^N y_k - \frac{N+1}{2} \cdot S$$

$$Y_k = S \cdot k + Y_o$$

## Statistics

- Sum = summation of data  
 SS = summation of data squared  
 $\bar{x}$  = mean  
 $\sigma$  = standard deviation of a sample  
 $x_i$  = entry value

## Summation

$$\text{Sum} = \sum_{i=1}^N x_i$$

$$SS = \sum_{i=1}^N x_i^2$$

## Mean

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

## Standard deviation

$$\sigma = \sqrt{\frac{1}{N-1} \sum_{i=1}^N x_i^2 - N\bar{x}^2}$$

# Glossary

## A

**Accrued Interest** Interest earned but not collected.

**Add-on Interest Rate** A term used in consumer finance to represent a particular method of calculating a finance charge. That is, when a loan is made a year's simple interest is "added-on" to the principal amount for each year of the life of the loan.

**Amortization** The gradual reduction of any amount over a period of time. A general term which includes various specific practices such as depreciation, depletion, write-off of intangibles, prepaid expenses, and deferred charges.

**Annuity** A series or one of a series of equal payments at fixed intervals; the right to receive such payments.

**APR** Annual Percentage Rate. Actual cost of a loan expressed as annual percent rate as required by U.S. Federal Reserve (Reg. Z—Truth-in-Lending).

## B

**Bond** A certificate of indebtedness in writing and often under seal.

**Bond Price** The price an investor is willing to pay for a bond. Involved is the determination of a value based on the redemption price of a bond when held to maturity or earlier date, the nominal or coupon rate of interest, and the effective rate or desired yield.

**Bond Yield** The effective annual rate of return to an investor when a bond is bought at a given price, pays a nominal or stated coupon rate and is held to maturity or earlier date.

## C

**Callable Bond** A type of bond permitting the issuer to pay the obligation before maturity by giving notice of redemption in a manner specified in the indenture.

**Chain Discount** A series of trade discount percentages or their total.

**Compound Interest** Interest resulting from the periodic addition of simple interest to principal, the new base thus established being the principal for the computation of interest for the following period.

**Coupon Rate** The rate at which dividends are paid to the bond holder expressed as an annual percent of the bond's face value, or par.

## D

**Declining Balance Depreciation** A method of computing the annual charge for depreciation. The amount of depreciation is obtained by applying a fixed percent to the diminishing balance of the asset account; that is, the balance after deducting the preceding period's depreciation.

**Declining Factor** The factor which determines the fixed percent to be applied in the Declining Balance Depreciation method. The percent or rate of depreciation is determined by dividing the declining factor by the asset's life (*in years*) and simply multiplying the result by 100 in order to express it as a percent.

**Depreciation** (See *Sum-of-the-Digits Amortization, Declining Balance Depreciation, Declining Factor*).

**Direct Reduction Loan** A loan in which the interest portion of the periodic payment is computed for the amount of the principal base outstanding for that period. The new principal base is then established by subtracting the remaining portion of the loan payment amount that was not designated as interest.

**Discount** The difference between the worth of a future benefit and its present value.

**Discounted Cash Flow** A cash flow occurring some time in the future which has been discounted by a given discount factor on a compounded basis; the present value of a future cash flow.

**Discounted Note** An instrument of indebtedness specifying the full repayment amount as par or face value. The current proceeds of the note are thus less than the face value, the difference representing the interest portion or the discount amount.

**Discounted Rate of Return** The effective periodic rate that would equate the present value of an investment with the accumulated present values of a stream of future cash flows, each appropriately discounted by the periodic rate.

## E

**Effective Rate** The ratio of income, periodically realized, to market value of an investment or to a sum invested; usually expressed on an annual basis and as a percent.

**Effective Yield** (See *Effective Rate*)

## F

**Finance Charge** Cost of consumer loan represented by the difference between amount borrowed and total amount to be repaid (in terms of dollars).

**Future Value** The amount yielded after compounding for a given number of periods at a stated rate of interest per period.

## L

**Linear Regression** A mathematical analysis expressing an average linear relationship between two variables; it is based on the assumption that observations of data will have a tendency to regress toward average values; often referred to as least-squares trend line or line of best fit.

## M

**Markup** The amount added to a base price for the purpose of determining a new and higher selling price.

**Maturity** The date on which an obligation becomes due.

**Mean** The result obtained by dividing the sum of two or more quantities by the number of items; usually denoted by a symbol such as  $\bar{x}$ . Also referred to as the arithmetic average or arithmetic mean.

**Mortgage** A lien on land, buildings, machinery, equipment, and other property, fixed or movable, given by a borrower to the lender as security for his loan.

## N

**Nominal Rate** A stated rate which is usually subdivided for compounding purposes resulting in a higher effective rate.

**Note** A written promise by a debtor to pay to—or to the order of—the creditor a stated sum of money, with or without interest, on a specified date.

## P

**Par** The nominal or face value of a security or note without any consideration of premium or discount.

**Percent** Any decimal fraction times 100.

**Percentage** The result of multiplying a given number or base by a percent.

**Periodic Payment** The discharge of a pecuniary obligation by a disbursement of money or by property or services accepted as the equivalent of money on a periodic basis.

**Present Value** The present sum which, if compounded at a given rate of interest per period over a given number of periods, will yield a stated future value.

**Price-to-call** The current price of a callable bond on the assumption that the bond is called at some price other than par and at a date prior to the maturity date.

**Principal** A sum on which interest accrues; capital, as distinguished from income.

## R

**Rate** (*See Percent*)

**Rebate** An allowance; a deduction; a refund of a part of the price paid for a good or service.

**Remaining Principal** The outstanding balance of a loan (*not including interest*) remaining unpaid by the borrower, usually after a specified point within the life of the loan.

**Rule of 78's** A method of amortizing a consumer finance charge using the sum-of-the-months' digits technique generally used for computing interest rebates (*amount of unearned finance charge*); (*See Sum-of-the-Digits Amortization*)

## S

**Settlement Date** The date on which payment (*usually for a security*) is settled.

**Simple Interest** The charge for the loan of money or for a deferment of the collection of an account, computed by applying a rate (*of interest*) against the amount of the loan or account. Contrasts with compound interest in that only the principal earns interest for the entire life of the transaction.

**Sinking Fund** Cash or other assets, and the interest or other income earned thereon, set apart for the retirement of a debt; the redemption of stock; or protection of an investment in depreciable property.

**Standard Deviation** A measure of dispersion around the mean.

**Sum-of-the-Digits Amortization** A method of amortizing, whereby the amount reduced each period is obtained by multiplying the total amount to be amortized by a fraction whose numerator is the digit representing the remaining number of amortization periods, and whose denominator is the sum of the digits representing the number of periods of amortization.

**Sum-of-the-Digits Depreciation** Depreciation method utilizing Sum-of-the-digits amortization technique.

## Y

**Yield** (*See Effective Rate*)

**Yield-to-call** The effective annual yield resulting from an investment in a callable bond to be held until an assumed call date and call price.

**Yield-to-maturity** The effective annual yield resulting from an investment in a bond to be held until maturity and redeemable at par.