Texas Instruments
electronic business calculator
The MBA™

KEY INDEX

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IMPORTANT

Record the serial number from the bottom of the unit and purchase date in the space below. The serial number is identified by the words "SERIAL NO." on the bottom case. Always reference this information in any correspondence.

MBA		
Model No.	**Serial No.**	**Purchase Date**

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INTRODUCTION

Your TI MBA™ advanced financial and statistical calculator represents a blending of versatile and powerful mathematical capabilities especially suited to applications in all areas of business, finance and statistical analysis. In addition, your calculator is programmable — you can easily design progams tailor-made to suit your own problem solving situations. With a simple program you can "teach" your calculator an entire sequence of keystrokes and have it "push its own buttons" in solving repetitive or lengthy problems for you. Results previously requiring books of tables and charts are now readily available on your machine.

Your calculator should prove a sound investment, allowing you to handle speedily a wide variety of business and financial calculations.

To begin getting acquainted with your calculator, let's take a few minutes to review each of its features and functions in the "Key Tour" that follows. Keep your TI MBA handy as you go through each key and its basic function. Subsequent chapters of this manual will provide you with a series of examples and discussions on how to use your calculator in various business, financial and statistical applications, as well as introducing you to the ease and power of programming your machine.

A "TOUR" OF THE BASIC KEYS ON YOUR *MBA*™ CALCULATOR: KEY DEFINITIONS WITH BRIEF EXAMPLES

The keyboard of your MBA has been organized and arranged to easily allow simple calculations such as balancing your checkbook as well as complex financial calculations of many kinds. The keys for different types of calculations are grouped together in logical clusters on the keyboard of the MBA. This section contains a definition of each key along with examples of how the keys in each cluster are used.

Turning It On — Automatic Power Saver

Slide the ON/OFF switch on the upper right of your machine to the right to apply power to the unit. A single zero in the display signals that power is "on" and the machine is ready for use. (If the display appears erratic or does not light up, the battery probably needs recharging. Simply turn the unit off, plug in the AC adapter provided with the machine, wait a few minutes, then proceed.)

Your calculator is designed to be energy efficient. After about 90 to 150 seconds of non-use, the display will shut down to a single decimal point traveling in the display. This keeps all of your current calculations "intact" while greatly decreasing the amount of power your machine consumes. Much less frequent battery recharges are required because of this built-in efficiency. To restore the display at any time, just proceed with a calculation, or press the [2nd] key twice.

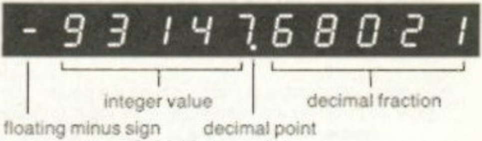
Data Entry Keys and Standard Display

[0] - [9] Number and data entry are handled in a straightforward way with the digit keys [0] through [9]. You can enter up to 10 digits from the keyboard; entries after the 10th are ignored.

[•] **Decimal Point Key** — For maximum versatility, your calculator operates with a floating decimal point. When entering numbers, the decimal remains to the right of the mantissa until [•] is pressed and the fractional part of the number is entered.

[+/-] **Change Sign Key** — When pressed after a number entry or a calculation, changes the positive or negative value (sign) of that number.

Your display will read out the first 10 digits of calculated results (correctly rounded). Internally, however, calculations are carried out to 11 digits. Here's how a calculated result such as −93147.68021 will appear in the display:



Dual Function Keys

Most of your calculator's keys have *dual* functions. The first function is printed right on the key, and its second function is written above that key. To execute a function shown on a key, simply press the desired key. To use the second function of a key, press the [2nd] key on the upper left of your keyboard, then press the key immediately below the desired second function. For example, to find the square of a number, simply press [x^2]. To find the square root ($\sqrt{x}$) of a number, press [2nd] and then the [x^2] key. In this book we'll indicate operations involving second functions with black key symbols like this: [2nd] [$\sqrt{x}$].

Note that when the [2nd] key is pressed twice in succession, the calculator will perform the first function operation. When [2nd] is pressed before a digit key, the [2nd] operation is ignored and the digit is entered.

Clearing the Calculator

[CE] **Clear Entry Key** — Pressing this key clears the last number you entered into the calculator (as long as the number wasn't followed by a function or operation key).

[CLR] **Clear Key** — Pressing this key clears the display and all pending operations but not any of the memories.

[2nd] [CA] **Clear All Key** — Clears everything including all memories.

OFF-ON — Turning the calculator off then on will also clear everything.

Basic Arithmetic Operations

[+] [−] [×] [÷] and [=] — **Basic Operation Keys.** Basic arithmetic is handled with the five basic operation keys [+] [−] [×] [÷] and [=]. The calculator has a simple-to-use entry method (the AOS™ entry method) which makes problem solution exceptionally easy. You key in the problem the way it is written, press [=], and get your result.

The amazing feature of the AOS entry method is that it automatically sorts out mixed operations in a problem for you and applies them in the correct (universally accepted) order as it calculates your result. (The AOS entry method will be discussed in more detail in the next section.)

When you press the [=] key, all pending operations (intermediate calculations waiting to happen inside your calculator) are completed. You get your result, and the calculator is automatically cleared when you start your next problem. This automatic clearing feature means that you do not have to clear the calculator before beginning each new problem.

Examples: 15 + 7 = ?
31 × 4 = ?
144 ÷ 3 = ?

Press	Display/Comments
15 [+] 7 [=]	22.
31 [×] 4 [=]	124.
144 [÷] 3 [=]	48.

The AOS™ Entry Method

Mathematics is a science which adheres to a variety of rules. One rule is that it never permits two different answers to the same sequence of operations. Because of this requirement — one solution for any computation — mathematicians have established a set of universally accepted rules when mixed operations are used in one calculation. For example, the problem 3 + 10 − 2 × 14 ÷ 7 = ? has only one correct answer: 9. Without a fixed set of rules, problems such as this could have several different results based on how you interpret the problem:

$3 + (10 - 2) \times 14 \div 7 = 19$

or $(3 + 10 - 2) \times 14 \div 7 = 22$

or $3 + 10 - 2 \times 14 \div 7 = 9.$

You can key this problem directly, left to right into your calculator with AOS entry and you will get the correct answer. The calculator sorts the operations you enter, applies them in the correct order, and lets you see what it's doing along the way.

Press	Display/Comments	
3 [+] 10 [−] 2 [×]	2.	
14 [÷] 7 [=]	9.	The correct answer.

Your calculator with AOS entry performs operations it receives from you in the following universally accepted order:

1) Single-variable function keys such as [ln x], [e^x], [x^2], [$\sqrt{x}$] and [1/x] act on the displayed number immediately — as soon as you push the key.
2) Percent-change calculations are completed next.
3) Exponential calculations (y^x and $\sqrt[x]{y}$) are done next. These are discussed further in a following section.
4) Multiplications and divisions are completed next, followed by
5) Additions and subtractions.

Finally, the equal key, [=], completes all operations.

When you were in elementary school, you may have heard the memory aid (My Dear Aunt Sally — MDAS) applied to help you remember the last part of this hierarchy (multiplications and divisions first, in order left to right, then additions and subtractions in the same way.) In a calculator equipped with AOS entry system, all of this is remembered for you.

There are cases in problem solving where you may want to specify the exact order in which an expression is evaluated, or the way in which a problem is completed. In those cases you can control the order with the parentheses keys [(] [)] (discussed in a moment). Parentheses demand a special first level of attention in mathematics, and they are treated that way by your calculator.

[(] [)] Parentheses Keys

Parentheses are available to allow you to designate the exact order in which you want a problem solved, allowing you to enter the sequence just as it is stated. Expressions you isolate in parentheses are evaluated completely to a single number result before they are combined with the rest of the problem. For example, $(3 + 2) \times 6$ can be entered in sequential order with the use of parentheses.

Press	Display/Comments	
[(] 3 [+] 2 [)] [×] 6 [=]	30.	Answer.

Another example: $5 + \frac{8}{9 - 2/3} = ?$

In handling expressions such as this, use parentheses to enclose the denominator.

$5 + \frac{8}{(9 - 2/3)}$. Rewriting this on a single line:

$5 + 8 \div (9 - 2 \div 3)$

Press	Display/Comments	
5 [+] 8 [÷]	8.	Calculator waits to add since division is done first
[(] 9 [−] 2 [÷] 3 [)]	8.33333333	Evaluates (9 − 2/3)
[=]	5.96	Completes $\frac{8}{(9 - 2/3)}$ and adds 5.

When in doubt, use extra parentheses!

The [=] key has the additional capability of automatically supplying closed parentheses to match any open parentheses at the end of the calculation.

Up to 4 pending operations (calculations waiting to be completed, due to hierarchy or open parentheses) can be held simultaneously in the calculator, except for two cases:

1. Computing %i when N, PMT, PV, and FV are given destroys all but the first two pending operations.
2. Computing DBD or IRR destroys all pending operations.

The Memory Keys

Your calculator is equipped with 12 versatile memory locations which allow you to store numbers and data you may need for use in subsequent calculations, and recall them at any time. You can also perform simple calculations in any of these memories; so in many ways you have "12 calculators" in one. The memories are also valuable when used in programming, as we'll see later on.

[STO] n, The Store Key — The key sequence [STO] **n** where **n** is one of the number keys ([0] → [9]), the decimal point key [•], or the change sign key [+/−], stores the displayed number in the assigned memory without removing it from the display. Any number previously stored in that memory is cleared first.

RCL n, The Recall Key — The RCL **n** key sequence recalls stored data from memory **n** to the display. (Again, **n** is one of the keys 0 through 9, • or +/-.) Use of this key does **not** clear the memory, and numbers may be recalled from a memory as many times as they are needed in a calculation.

Example: Store 3.012 in memory 4, then recall it.

Press	Display/Comments	
3.012 STO 4	**3.012**	Stored in memory 4
CLR	**0**	Clears the display but not the memories
RCL 4	**3.012**	Recalls number from memory 4.

The RCL key can also be used along with the financial keys on your calculator, as we'll discuss later on.

SUM n, The Sum to Memory Key — The key sequence SUM **n** algebraically adds the displayed quantity to the contents of memory **n** (the sum remains stored in memory **n**). This key sequence does not affect the displayed number or calculations in progress.

2nd PRD n, Memory Product Key Sequence — This sequence multiplies the contents of memory **n** by the value in the display and stores the result in memory **n**. This does not affect the displayed number or calculations in progress.

Example: Store 2 in memories 0 and 1. Then add 3.5 to memory 0 and multiply memory 1 by 3.5.

Press	Display/Comments	
2 STO 0 STO 1	**2.**	Stores 2 in memories 0 and 1
3.5 SUM 0 2nd PRD 1	**3.5**	Sums 3.5 to memory 0 and multiplies number in memory 1 by 3.5
RCL 0	**5.5**	Recalls memory 0 which contains 2 + 3.5
RCL 1	**7.**	Recalls memory 1 which contains 2 × 3.5.

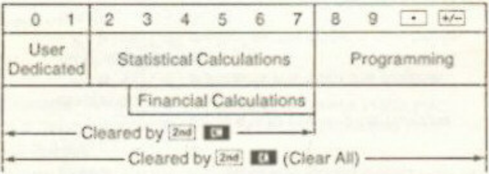
[2nd] [EXC] **n, Memory Exchange** — This sequence exchanges the contents of memory **n** with the number in the display. (The display value is stored in memory **n**, and the previously stored value is displayed.) This key combines the store and recall operations into a single key. Use of this key, like the other memory keys, does not disturb other calculations you may have in progress.

[2nd] [CM] **Clear Memories** — This sequence clears the contents of memories 0 through 7. [2nd] [CA] clears the contents of all memories. (Note: [2nd] [CM] does not reset the fix decimal condition, but [2nd] [CA] does.)

Memory Organization

Because of the complexity of some financial and statistical calculations that will be discussed later, the calculator uses certain memories to store data and results when handling these advanced computations. Only memories 0 and 1 are totally user dedicated and are not used by the calculator in performing financial, statistical, or programming operations*. The chart below illustrates the arrangement and use of the calculator's 12 memories.

Memory Number



Notice that statistical calculations use memories 2 through 7 and financial calculations use memories 3 through 7. For this reason, you cannot perform calculations which use both financial and statistical functions at the same time. Also note that when you clear the memories ([2nd] [CM]) this does not clear a program which you have entered in the calculator.

*Note: The IRR routine is an exception; see page 32.

[%] **Percent Key** — When the [%] key is pressed, a number entered in the display is immediately converted to a decimal percent (multiplied by 0.01). If you enter 43.9 and press [%], 0.439 is displayed.

The real power of the [%] key is turned on for you when you use it in combination with an operation key. This allows "mark up" and "mark down" as well as straight and inverted percentage problems to be solved. The rules for using the [%] key in these situations are tabulated below. Simply press the brief sequences shown to perform the desired operation on the number in the display.

[+] n [%] [=] adds **n**% to the original number displayed.
[−] n [%] [=] subtracts **n**% from the original number displayed.
[×] n [%] [=] multiplies the original number in the display by **n**%.
[÷] n [%] [=] divides the original number in the display by **n**%.

When the [%] key is used with the [+] and [−] operations, add-on and discount percentages are easily calculated.

Add-on Example: How much will you pay for an item costing $15 when a 5% sales tax is added?

Press	Display/Comments	
15 [+] 5 [%]	.75	Amount of tax
[=]	15.75	Total amount you'll pay.

Discount Example: The retail price of an item is $54.25. What is the sale price if it's to be discounted 15%?

Press	Display/Comments	
54.25 [−] 15 [%]	8.1375	Amount of discount
[=]	46.1125	Sale price is $46.11.

When the [%] key is used with the [×] and [÷] key, "straight" and "inverted" percentage problems often encountered in business can be easily solved.

Example Using [×]: A watch company has shipped 40% of your 12000 unit order. How many watches are on the way? In other words, what is 40% of 12000?

Press	Display/Comments	
12000 [×]	**12000.**	
40 [%]	**0.4**	Decimal equivalent of 40%
[=]	**4800.**	Number of watches on the way.

Example Using [÷]: 30 deliveries have satisfied 15% of your customers. How many deliveries are needed to satisfy all your customers? In other words, 30 is 15% of what number?

Press	Display/Comments	
30 [÷] 15 [%]	**0.15**	Decimal equivalent of 15%
[=]	**200.**	Total deliveries needed.

[2nd] [Δ%] Percentage Change Key

The sequence, X_1 [2nd] [Δ%] X_2 [=], calculates the percentage of change between the two values, X_1 and X_2 where:

$$\Delta\% = \frac{X_2 - X_1}{X_1} \times 100$$

Example: What is the percentage increase in the cost of a raw material that formerly cost $814.75 and now costs $906.25?

Press	Display/Comments	
814.75 [2nd] [Δ%]	**814.75**	
906.25 [=]	**11.23043879**	Percent increase in cost.

The cost has increased over 11%.

Mathematical Function Keys

Your calculator is equipped with a spectrum of keys designed to handle the most commonly encountered mathematical calculations at the touch of a key.

[x^2] **The Square Key** — This key calculates the square of the number x in the display.

Example: $(4.235)^2 = ?$

Press	Display/Comments
4.235 [x^2]	**17.935225** Answer

[2nd] [$\sqrt{x}$] calculates the square root of the number in the display (the number may not be negative).

Example: $\sqrt{6.25} = ?$

Press	Display/Comments
6.25 [2nd] [$\sqrt{x}$]	**2.5** Answer

[1/x] **The Reciprocal Key** — The reciprocal key [1/x] divides the display value (x) into 1.

Example: $\frac{1}{3.2} = ?$

Press	Display/Comments
3.2 [1/x]	**0.3125** Answer

[lnx] **Natural Logarithm Key** — The natural logarithm key [lnx] calculates the natural logarithm (base e) of the number x in the display (x should not be negative or zero).

Example: ln 1.2 = ?

Press	Display/Comments
1.2 [lnx]	**0.182321557** Answer

[2nd] [e^x] **Natural Antilogarithm** —The key sequence [2nd] [e^x] calculates the natural antilogarithm of the number in the display (raises e to the power x shown in the display).

Example: $e^{1.25} = ?$

Press	Display/Comments
1.25 [2nd] [e^x]	**3.490342958** Answer

[2nd] [y^x] **Universal Roots and Power** — Your calculator allows you to easily raise any number (y) to any power (x) desired.

To raise y to the xth power (y^x) simply:

- Enter the number, y
- Press [2nd] [y^x]
- Enter the power, x
- Press [=] (or any operation key).

To take the "xth" root of any number y ($\sqrt[x]{y}$):

- Enter the number, y
- Press [2nd] [y^x]
- Enter the root, x
- Press [1/x]
- Press [=] (or any operation key).

Note that in either case the variable y should be a positive number and that attempting to take the 0th root of a number results in an error condition.

Here are a few examples illustrating the use of these key sequences:

Example: $3 + 2^3 + 6 = ?$

Press	Display/Comments
3 [+] 2 [2nd] [y^x] 3 [+] 6 [=]	**17.** Answer.

(Note: Be certain to allow a moment for your calculator to complete calculations involving y^x before entering new data, or an error may result).

Example: $\sqrt[3.12]{1460} = ?$

Press	Display/Comments
1460 [2nd] [y^x] 3.12 [1/x] [=]	**10.33274375** Answer

Example: $(1.0075)^{36} = ?$

Press	Display/Comments
1.0075 [2nd] [y^x] 36 [=]	**1.308645372** Answer

[2nd] [CONST] Calculations with a Constant

Here is a labor saving (and accuracy increasing) feature of your calculator! The [2nd] [CONST] key sequence stores a number **and an operation** for use in repetitive calculations. Once the number and operation are stored, you just key in the numbers you want them to work on, press [=], and you get your answer. Calculations using the [2nd] [CONST] feature can be repeated as many times as you need them. Here's how it works:

- Enter the repetitive number (we'll call it m)
- Enter the operation you want to work with it
- Press [2nd] [CONST]

From then on in, you just:

- Enter the number you want to operate on
- Press equals [=]

The [2nd] [CONST] feature works in the following way with operation keys on your machine:

m [+] [2nd] [CONST]	adds **m** to each subsequent entry
m [−] [2nd] [CONST]	subtracts **m** from each subsequent entry
m [×] [2nd] [CONST]	multiplies each subsequent entry by **m**
m [÷] [2nd] [CONST]	divides each subsequent entry by **m**
m [2nd] [y^x] [2nd] [CONST]	raises each subsequent entry to the **m**th power — it calculates y^m
m [1/x] [2nd] [y^x] [2nd] [CONST]	takes the **m**th root of each subsequent entry — calculates $\sqrt[m]{y}$

Example: Multiply 2, 4, 6 and 7 by 3.14159.

Press	Display/Comments	
3.14159 [X] [2nd] [CONST]	3.14159	Enters the constant and the operation
	Now enter the number you want to operate on and press [=].	
2 [=]	6.28318	
4 [=]	12.56636	
6 [=]	18.84954	
7 [=]	21.99113	

[2nd] [FIX] n, Fixed Decimal Mode

The sequence [2nd] [FIX] n creates a fixed decimal-point mode of operation. The decimal point can be set to display from 0 to 8 decimal places. [2nd] [FIX] 9 restores floating point operation. Floating point operation is also restored each time [2nd] [CA] (clear all) is pressed.

Example: Suppose you want to know how much an item costs with sales tax. You'd like your calculator to round off your answer to the nearest cent (two decimal places). The price is $15.95 plus 5% tax.

Press	Display/Comments	
[CLR] [2nd] [FIX] 2	0.00	Fixes decimal at 2 places
15.95 [+] 5 [%] [=]	16.75	Answer rounded to 2 places

The result is rounded off to 2 decimal places, but remaining digits of the calculation are retained internally and can be displayed. If you press [2nd] [FIX] 9 to restore floating point operation, the calculator displays 16.7475.

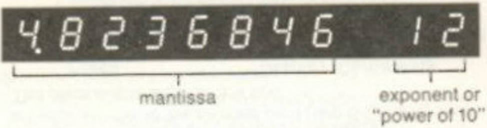
[x:y] **x Exchange y Key** — This key exchanges the last two numbers (not digits) entered, and is used to exchange divisor and dividend in division problems and for data entry and result display in certain financial and statistical calculations. This will be discussed in more detail in a later section.

Special Display Formats

Scientific Notation. For handling very large or very small calculated results, your calculator is equipped to handle numbers in scientific notation. Calculated results that exceed ten digits (display limit) to the left or right of the decimal point are automatically displayed in scientific notation. This format consists of a number (mantissa), multiplied by ten raised to some power (or exponent). For example, the result of the calculation

4,823,684.58 [×] 1,000,000 [=]

will be expressed as 4.8236846×10^{12} by your calculator. The calculator's display will show.



In scientific notation, a positive exponent indicates how many places the decimal point of the mantissa should be shifted to the right to produce the actual number. Conversely, if the exponent is negative, the decimal point should be moved to the left.

For example, the number 3.86×10^{13} is equal to

38,600,000,000,000.

The number 4.51×10^{-5} is equal to

.0000451

Because of display space, your calculator can display only 8 digits of the mantissa (correctly rounded). Internally, the mantissa is carried to 11 digits. All numbers between −9,999,999,999 and +9,999,999,999 inclusive are displayed in standard format, even if larger numbers have been used during a calculation. Whenever any result occurs within the standard format range, that format is used for the display.

Entering Very Large or Very Small Numbers. Entries of extremely large or small numbers can be made on your calculator using scientific notation and the [2nd] [y^x] key sequence. In scientific notation a number is expressed as:

(mantissa) x 10$^{(power)}$

On your calculator you can enter a number in scientific notation using the following key sequence:

- Enter the mantissa
- Press [X] 10 [2nd] [y^x]
- Enter the power of 10
- Press [=].

Note that the calculator will not display your number in scientific notation unless it falls in the range indicated in the previous section.

Displayed Error Indications. The display will flash whenever the limits of the calculator are exceeded or when an improper operation is requested. Press [CE] to remove the error indication from the display. This also eliminates the number and operation that caused the error condition. Calculations or data entries up to that point are preserved. Pressing [CLR] not only removes the error condition, but also clears the calculator (except for the memories). See Appendix A for a detailed list of conditions that will create a flashing error condition.

II. FINANCIAL AND BUSINESS FUNCTIONS

The real power of the TI MBA is its ability to handle speedily a wide variety of business and financial problems with keys specially dedicated to this function. In this section we'll go through the special financial and business capabilities of your machine, with some quick illustrative examples giving you a feel for how to take fullest advantage of these capabilities.

Compound Interest

[N], [%i], [PV], [FV] **Compound Interest Keys—** These keys are used to enter values for number of periods, periodic interest rate, present value and future value, respectively. To enter any of these values, simply enter the number in the display and press the appropriate key. For example, a period of five years can be entered by pressing 5 and then pressing [N]. Having entered any three of these values, pressing the compute key, [CPT], followed by the key representing the unknown value signals the calculator to compute that value. ***The calculator recognizes the difference between a compound interest problem and an annuity problem by the fact that the payment is zero.*** To insure proper operation when working compound interest problems, be sure to begin the problem with [2nd] [CM] (clear memories) or use the sequence 0 [PMT] to make the payment zero. If you have just turned the calculator on, this is not necessary, since turning the calculator off then on clears everything.

Example: $2000 is invested for 3 years at 12% compounded annually. What is the future value of the investment?

Press	Display/Comments	
[2nd] [CM] [2nd] [Fix] 2	0.00	Clear memories 0–7 and fixes decimal at 2 places
2000 [PV]	2000.00	Enters present value
3 [N]	3.00	Enters number of years
12 [%i]	12.00	Enters rate of return
[CPT] [FV]	2809.86	Future value

(Don't clear your calculator or shut if off at this point.)

If the interest were compounded monthly (12% ÷ 12 = 1% monthly interest), what would the value be at the end of the same 3 years? If you do not clear your calculator, you won't have to enter the $2000 present value for this example.

Press	Display/Comments	
12 [÷] 12 [=] [%i]	1.00	Computes and enters monthly interest rate
3 [×] 12 [=] [N]	36.00	Computes and enters the number of months
[CPT] [FV]	2861.54	Future value

By more frequently compounding the earned interest, more money is made.

Notice that the interest rate per period must be adjusted to correspond to the time interval in which the compounding occurs, when handling any financial calculation on your calculator.

Annuities

An annuity is any series of equal payments made at regular intervals of time. There are basically two types of annuities differentiated by payments being made at the beginning or end of each period.

An *ordinary annuity* (sometimes called payments in arrears) involves payments made at the end of each payment period. In *annuity due* situations (also called payments in advance) the payments are made at the beginning of each period in anticipation of services to be received during the coming period. (We'll discuss annuities in greater detail in Chapter VI.)

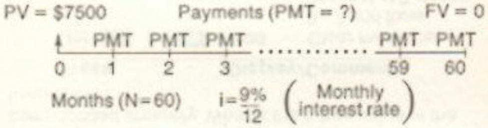
[PMT] **Payment Key** — This key is used with the other financial keys, [N], [%i], [PV], and [FV], to enter or calculate the payments for an annuity.

[2nd] [DUE] — The key sequence [2nd] [DUE] is used in computing results for annuities due.

Ordinary Annuities (Loans, Mortgages, etc.)

When you take out a loan, you establish a debt of some present value to be repaid with interest by certain payments for a fixed number of periods. Problem situations such as this are often visualized on a time line diagram of the sort shown below. In these diagrams, a horizontal line is used to illustrate the time period of a given financial problem or situation, with the payment periods, interest rate per period, present value, future value and all appropriate variables indicated.

Example: The super ski boat Don couldn't live without required him to borrow $7500 at 9% per year compounded monthly. He decides to repay the loan in 5 years by 60 monthly payments. What are his monthly payments?



Press	Display/Comments	
CLR 2nd FIX 2	0.00	Clears and sets display to round to nearest cent
7500 PV	7500.00	Enter present value
9 ÷ 12 = %i	0.75	Computes and enters monthly interest
60 N	60.00	Enters number of months
CPT PMT	155.69	

Don's payments are $155.69 per month.

Annuities Due.

An annuity due is one in which the payments are made at the beginning of each payment period. When making calculations involving annuities due, the key sequence 2nd DUE is used rather than CPT when computing a result.

Example: Present value for annuity due. You can lease a feed store for $350 per month with the lease payment due at the first of each month. What is the present value of the equivalent yearly cost of the lease, figuring that you could earn 6% annual interest compounded monthly if you put the payments into a bank?

Rent payments	350	350	350	350	350
Number of months	0	1	2 …	11	12

PV = ? $i = \frac{6\%}{12}$

Press	Display/Comments	
CLR 2nd FIX 2	0.00	Clear and fix decimal at 2 places
350 PMT	350.00	Enters payment amount
12 N	12.00	Enters number of periods
6 ÷ 12 = %i	0.50	Computes and enters monthly interest
2nd DUE PV	4086.96	The present value of equivalent yearly lease (if your money can earn 6% annual interest compounded monthly.)

Amortization

A debt is termed *amortized* when all principal and interest have been repaid, usually by equal payments at regular intervals. For loans repaid with equal payments at equal time intervals, your calculator has special keys to determine how much of each payment is going for interest and how much for principal.

2nd P/I **Principal and Interest** — The key sequence 2nd P/I can be used to determine the principal for a fully amortized direct reduction loan for any payment number entered in the display. Then pressing x:y determines the amount of interest paid by that payment. The information you must enter first is the percent interest (%i), the payment amount (PMT), the present value (PV) or loan amount, and the payment number.

Example: You want to borrow $10,000 and repay it over a period of five years with the payments due at the end of each year. The yearly interest rate is 8%. Calculate your payment amount and determine the principal and interest paid by each payment for five years.

Press	Display	Comments
[2nd] [CM] [2nd] [FIX] 2	0.00	Clears memories and fixes decimal at two places.
10000 [PV]	10000.00	Enters loan amount
8 [%i]	8.00	Enters interest rate
5 [N]	5.00	Enters number of payments
[CPT] [PMT]	2504.56	Computes payment
1 [2nd] [P/I]	1704.56	Principal paid with first payment
[x:y]	800.00	Interest paid with first payment
2 [2nd] [P/I]	1840.93	Principal paid with second payment
[x:y]	663.63	Interest paid with second payment
3 [2nd] [P/I]	1988.20	Principal paid with third payment
[x:y]	516.36	Interest paid with third payment
4 [2nd] [P/I]	2147.26	Principal paid with fourth payment
[x:y]	357.30	Interest paid with fourth payment
5 [2nd] [P/I]	2319.04	Principal paid with fifth payment
[x:y]	185.52	Interest paid with fifth payment

(Leave your calculator on for the next example.)

[2nd] [BAL] **Loan Balance**— The sequence [2nd] [BAL] can be used to determine the remaining loan balance for a fully amortized direct reduction loan after a given payment.

Example: In previous example, suppose that you want to know what your loan balance will be right after the third payment. It is not necessary to reenter PV, %i, N or PMT because these values are retained in the calculator. Simply enter the payment number in the display and press [2nd] [BAL].

Press	Display/Comments
3 [2nd] [BAL]	4466.30 Balance at the end of the 3rd year

(Leave your calculator on for the next example.)

[2nd] [ACC] **Accumulated Interest** — The sequence [2nd] [ACC] can be used to determine the interest paid between any two payment numbers of a fully amortized direct reduction loan. Again it is not necessary to reenter PV, %i, N or PMT. Simply enter the first payment number, press [x:y], enter the second payment number, and press [2nd] [ACC]. The display will then show the accumulated interest between the two payment numbers inclusive. (You can then press [x:y] to display the balance remaining after the second payment number you entered.)

Example: Continuing the above example, determine the accumulated interest between the first and third payments and the balance remaining after the third payment.

Press	Display/Comments
1 [x:y]	2319.04 Enter first payment number. (Displayed result depends on previous calculations.)
3	3 Enter second payment number
[2nd] [ACC]	1180.00 Accumulated interest
[x:y]	4466.30 Balance at end of third year

The interest accumulated between the first and third years is $1180.00 and the balance remaining after the third payment is $4466.30. You can see that the interest is the sum of the second and third years' interest from the previous example detailing principal and interest for each year of the loan: $663.63 + 516.36 = $1179.99 (about $1180.00).

[DBD] **Days between Dates Key** — In some financial calculations the number of days between two dates is used to determine the number of periods, N. The [DBD] key can be used to compute the number of days between any two dates after March, 1582. The format for entering the dates requires that you enter the number of the month first, press [•], then enter two digits for the day and then four digits for the year. The display will show the date as: MM. DDYYYY. The sequence MM. DDYYYY [DBD] MM. DDYYYY [=] gives the actual number of days between the two dates. A positive number is displayed when the first date entered is earlier in time. Please note that the calculator will not reject illegal dates (February 30, April 32, etc.) Erroneous results will occur in these cases.

Example: Suppose you want to know the number of periods (months) between the day you bought your house (April 20, 1969) and the present (May 25, 1977) so that you can determine the remaining balance for your mortgage. First we'll calculate the number of days, then years, then months.

Press	Display/Comments	
[2nd] [CA]	Clear completely for following calculations	
4.201969 [DBD]	**4.201969**	First date
5.251977	**5.251977**	Second date
[=]	**2957.**	Days between dates
[÷] 365 [=]	**8.101369863**	Number of years
[×] 12 [=]	**97.21643836**	Number of months

In making your calculation for an amortization schedule, use 97 for the number of periods, N.

Variable Cash Flows

Many times you are confronted with a choice of investments. In analyzing these situations, you'll sometimes be faced with various sums of money, often of differing amounts, that you'll either receive or pay out. These "sums of money" are called "cash flows." One good procedure when weighing investment alternatives is to examine the cash flow that will result from various investments by calculating the **present day equivalents** of these flows and comparing them. There are keys on your calculator especially dedicated to this type of computation — called discounted cash flows.

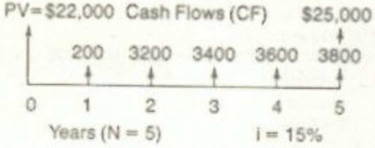
[2nd] [NPV] **Net Present Value** — The [NPV] key is used to find the net present value of a series of cash flows. By requiring a certain minimum rate of return and estimating the cash flows for each period, the discounted cash flows can be added to see if the investment is worthwhile. If the sum or net present value of all discounted cash flows is positive, then the investment exceeds the minimum rate of return you desire.

To compute the net present value of a series of flows at any assumed rate of return you desire, simply follow this key sequence.

- Before beginning the computation, clear the memories by pressing [2nd] [CM]
- Enter your desired rate of return on the investment (the desired discount rate) and press [%i]
- Then enter the *initial expense* of the investment, and press [+/-] [PV]
- Then you can enter each cash flow and discount it back to the present by
  - — Entering the period at which the cash flow occurs (N)
  - — Pressing [x:y]
  - — Entering the amount of the cash flow
  - — Pressing [2nd] [NPV]
  - — Repeating for each cash flow
- The display will then show the net present value of the cash flows discounted to the present.

If the value in the display after you've entered all of the cash flows is **positive** then your investment **does** achieve at least your desired rate of return. If the display value of the end of the calculation is **negative,** then you do **not** achieve your desired rate of return.

Example: You have the opportunity to purchase a small ice cream shop for $22,000. You desire a 15% annual return rate on your investment. Will the following anticipated end of year net income (cash flows) shown below meet your 15% requirements? You plan to sell the shop for $25,000 in five years.



Press	Display/Comments	
[2nd] [CM] [2nd] [FIX] 2	0.00	Clears memories and fixes decimal at 2
15 [%i]	15.00	Enters discount rate
22000 [+/-] [PV]	−22000.00	Stores initial expense and enters as PV. (An expense is a negative cash flow.)
1 [x:y] 200 [2nd] [NPV]	−21826.09	Enters $200 at the end of the first year (shows adjusted PV).
2 [x:y] 3200 [2nd] [NPV]	−19406.43	Enters $3200 at the end of the second year (shows adjusted PV).
3 [x:y] 3400 [2nd] [NPV]	−17170.87	Enters $3400 at the end of the third year (shows adjusted PV).
4 [x:y] 3600 [2nd] [NPV]	−15112.56	Enters $3600 at the end of the fourth year (shows adjusted PV).
5 [x:y] 3800 [2nd] [NPV]	−13223.29	Enters $3800 at the end of the fifth year (shows adjusted PV).
5 [x:y] 25000 [2nd] [NPV]	−793.87	Enters $25000 selling price at the end of the fifth year (shows adjusted PV).

The result is negative, so the investment does not return 15% per year. (Leave your calculator on for the next example.)

What if you keep the shop another year? Suppose that your net income at the end of the 6th year is $4000 and you sell the shop for $27,000. You need to remove the $25,000 selling price.

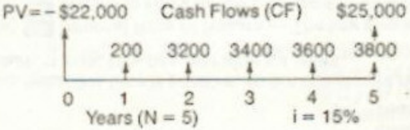
Enter	Display/Comments	
5 [x:y] 25000 [+/−] [2nd] [NPV]	−13223.29	NPV (without sale of shop) after 5 years.
6 [x:y] 4000 [2nd] [NPV]	−11493.98	Enters $4000 at the end of the sixth year.
6 [x:y] 27000 [2nd] [NPV]	178.87	NPV (including sale of shop) after 6 years.

The result this time is positive, so the investment does return at least 15% per year after six years.

[2nd] [IRR] **Internal Rate of Return** — The key sequence [2nd] [IRR] is used to solve for the periodic interest rate which will make the NPV of a series of cash flows equal to zero. The result is the interest rate which will allow you to "break even" at the end of the period in which the last cash flow was entered. As many as 12 cash flows can be entered in the calculator's memories with the initial expense stored in memory 0, cash flow 1 (occurring at the end of the first time interval) stored in memory 1, cash flow 2 (occurring at the end of the second time interval) stored in memory 2, etc. The calculator assumes that the cash flow entered in memory 0 is cash outflow (negative

cash flow) since it generally represents an initial investment. (Note: If the initial cash flow to be stored in memory 0 is a cash inflow, it must be entered as a negative number.)

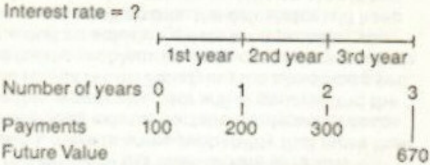
Example: What was the actual rate of return from the ice cream shop in the previous example for the first five years? (Note that the solution for internal rate of return, IRR, is extremely complex. A computation time of 30 seconds or more may be required after you press [2nd] [IRR].)



Press	Display/Comments	
[2nd] [CA] [2nd] [FIX] 2	0.00	Clears all and fixes decimal at 2 places
22000 [STO] 0	22000.00	Stores initial expense.
200 [STO] 1	200.00	Stores CF_1 (Cash flow at end of first year).
3200 [STO] 2	3200.00	Stores CF_2
3400 [STO] 3	3400.00	Stores CF_3
3600 [STO] 4	3600.00	Stores CF_4
3800 [+] 25000 [=] [STO] 5	28800.00	Selling price plus CF_5
[2nd] [IRR]	14.03	Rate of return is 14.03%

This represents about a 14% rate of return per year on the investment.

Another use of [2nd] [IRR] — The [2nd] [IRR] key sequence may also be used to find the internal rate of return needed for several cash flows to amount to a set future value. For instance, let's assume that you are going to receive payments of 100, 200, 300 as shown on the time line. You'd like to know the interest rate which would make these payments worth $670 at the end of the third year.



In this case the cash flow which occurs at the beginning ($100) is a cash inflow so it will be entered as a negative quantity. At the end of the 3rd year, you want the payments to be worth $670. We'll enter this as a negative $670 since this is the amount you want to be able to pay out at the end of the third year (based on the $100, $200 and $300 payments you receive at the interest rate you'll find).

Press	Display/Comments	
[2nd] [CA] [2nd] [FIX] 2	0.00	Clears everything and fixes decimal at 2 places.
100 [+/-] [STO] 0	−100.00	The first cash inflow (must be negative in memory 0 for an inflow).
200 [STO] 1	200.00	Enters $200 cash inflow at end of first year.
300 [STO] 2	300.00	Enters $300 cash inflow at the end of the second year.
670 [+/-] [STO] 3	−670.00	Enters the amount you want to be able to pay out at the end of the third year.
[2nd] [IRR]	6.77	Interest rate you would have to receive to achieve your goal.

IMPORTANT NOTE ON INTERNAL RATE OF RETURN COMPUTATIONS:

Due to the nature of the internal rate of return calculation, there is some probability that more than one answer may exist to certain problems. In cases such as this, your calculator will in general find the smallest rate of return satisfying the conditions you entered for the problem. In some cases, however, it's possible that no solution exists for a problem you enter. In cases such as this, the calculator will keep attempting to locate a solution until you stop it by turning the machine OFF and ON.

Because the IRR function uses all the memories of the calculator, you can't do other financial or statistical routines or retain a stored program while computing IRR. Before beginning, either press [2nd] [CA] or turn the calculator OFF and ON to clear the entire unit.

III. STATISTICAL FUNCTIONS

Your calculator is equipped to handle statistical calculations commonly encountered in many business situations as well as any other applications where the collection and analysis of data may be involved.

Mean, Standard Deviation, and Variance

The most common statistical calculations used in "boiling down" a set of data points are the mean, standard deviation, and the variance. (The *mean* value represents the "central" tendency of your data, the *standard deviation* and *variance* are parameters that indicate how "spread out" or variable the data is.) You can also simultaneously analyze two sets of data, allowing you to examine relationships between them.

To collect and analyze sets of data, here's the procedure:

- Begin any and all statistical calculations by pressing [2nd] [CSR].

If you have only one set of data to analyze:

- Enter first data point
- Press [Σ+]
- Repeat for all data points

- Press [2nd] [Mean] to calculate the mean of the data
- Press [2nd] [S.D.] to calculate the standard deviation of the data using n-1 weighting (normally used for *sample* data).
- Press [2nd] [VAR] to calculate the variance of the data (with N weighting).

(continued)

If you have two sets of data to analyze simultaneously:

Call the two sets of data "x" (independent) and "y" (dependent) arrays of data.

- Enter first "x" data point
- Press [x:y]
- Enter first "y" data point
- Press [Σ+]
- Repeat for all points

- Press [2nd] [Mean] to calculate the mean of the "y" data points
- Press [CPT] [2nd] [Mean] to calculate the mean of the "x" data points

(continued)

one set (continued)

- Press [2nd] [VAR] [2nd] [√x] to calculate the standard deviation of the data (with N weighting).

  ("N weighting" means that the total number of data points is used in the calculation of the variance — this type of variance is called a population variance).

  If you make a mistake entering a data point, simply reenter the incorrect number and press [2nd] [Σ-]. Then enter the correct number and press [Σ+].

two sets (continued)

- Press [2nd] [S.D.] to calculate the standard deviation of the "y" data using n-1 weighting
- Press [CPT] [2nd] [S.D.] to calculate the standard deviation of the "x" data using n-1 weighting.
- Press [2nd] [VAR] to calculate the variance of the "y" data points
- Press [CPT] [2nd] [VAR] to calculate the variance of the "x" data points
- Press [2nd] [VAR] [2nd] [√x] to calculate the standard deviation of the "y" data points (using N weighting)
- Press [CPT] [2nd] [VAR] [2nd] [√x] to calculate the standard deviation of the "x" data points (using N weighting.)

Example: You're teaching a course, and the first set of test scores is in. You'd like to see how well the class is doing. The scores are tabulated below:

96	65	81
85	76	86
57	98	75
78	100	72
81	70	80

Press	Display/Comments	
[2nd] [CM]	0	Be sure to clear the memories
96 [Σ+]	1.	The calculator counts
85 [Σ+]	2.	your data points for you
⋮ (continue for all points)		
72 [Σ+]	14.	
80 [Σ+]	15.	
[2nd] [Mean]	80.	Class average
[2nd] [S.D.]	11.9702011	Standard deviation (n-1 weighting)
[2nd] [VAR]	133.7333333	Variance (N weighting)

NOTE: If your data represents an entire population and not a small sample taken from a large population, N weighting is usually used to compute the standard deviation. This is easily calculated by taking the square root of the variance.

[2nd] [VAR] [2nd] [√x] 11.56431292

Linear Regression

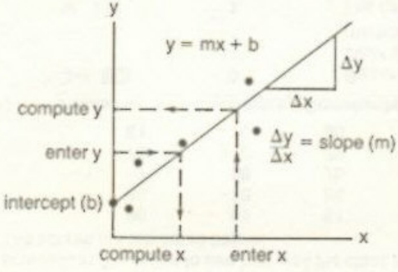
In both "linear regression" and "trend line analysis" situations, your calculator is mathematically drawing a straight line graph through a series of data points you know and can enter into the machine. You can then make projections using this line, or analyze data in regions you're unsure of. We'll briefly describe the needed key strokes, and then go through a couple of examples to show you situations where linear regression and trend line analysis may be useful.

NOTE: The actual placement of the line is determined by a least squares linear regression that minimizes the sum of the squares of the deviations of the actual data points from the straight line of best fit. The linear equation of the form $y = mx + b$ is determined for the line.

Linear regression is extremely useful for analyzing historical data and using the results to project future information. The data points you know are entered by their "x" and "y" coordinates using the following key sequence:

- Enter each "x" data point value
- Press [x:y]
- Enter each "y" data point value
- Press [Σ+]
- Continue until all points are entered.

Your calculator is now ready to draw the best straight line through your points and give you the following information from it:



- Press [2nd] [SLOPE] to calculate the slope of the calculator's line through your points.
- Press [2nd] [INTCP] to calculate the y-intercept of the calculator's line.

NOTE: If the line is vertical, no y-intercept exist and the slope is undefinable. Calculating the slope will yield an error condition and additional "x" points cannot be predicted. If the line is horizontal, the slope is 0 and new "y" values cannot be predicted.

To estimate a "y" value for any given "x" value you select:

- Enter "x" and press [2nd] [y'] — the corresponding "y" value is displayed.

To estimate an "x" value for any "y" value you select:

- Enter "y" and press [2nd] [x'] — the corresponding "x" value is displayed.

To get a feel for how well the two sets of variables are related:

- Press [2nd] [CORR] — the calculator displays the correlation coefficient of the data. A value close to one indicates a "good" relationship between the sets of data, a value near zero indicates that there's little relationship between your "x" and "y" values.

Example: NoDie Life Insurance Company has found that the volume of sales varies according to the number of sales people employed.

Number of sales people ("x" data)	7	12	3	5	11	8
Sales in thousands/mo. ("y" data)	99	152	81	98	151	112

Based on the present trend, how many sales people does this company need for $200 thousand in monthly sales? What monthly sales would 15 sales people generate?

Press	Display/Comments	
[2nd] [CM]	0	Clear memories
7 [x:y] 99 [Σ+]	1.	1st data point (7,99) entered
12 [x:y] 152 [Σ+]	2.	2nd data point (12,152) entered
3 [x:y] 81 [Σ+]	3.	3rd data point (3,81) entered
5 [x:y] 98 [Σ+]	4.	4th data point (5,98) entered
22 [x:y] 151 [Σ+]	5.	5th data point (11,151) entered incorrectly.
	To remove the incorrect entry, reenter but press [2nd] [Σ-]	
22 [x:y] 151 [2nd] [Σ-]	4.	Removes incorrect entry
11 [x:y] 151 [Σ+]	5.	5th data point entered correctly
8 [x:y] 112 [Σ+]	6.	6th data point entered correctly
200 [2nd] [x']	17.81578947	The number of people (x) needed for $200 thousand in sales.
15 [2nd] [y']	176.5561798	The number of thousands of dollars in sales which would result from 15 people.
[2nd] [SLPE]	8.325842697	Slope of line
[2nd] [INTCP]	51.66853932	y-intercept of line
[2nd] [CORR]	0.969757193	Correlation factor.

(Leave your calculator on for the next example.)

The correlation coefficient indicates the degree of correlation between two sets of numbers, such as the number of sales people and the amount of sales in our example. A value close to one indicates a high *positive* correlation and a value close to minus one indicates a high *negative* correlation. A value of zero indicates that the two sets of numbers are not related.

Example: Usually, increasing the number of sales people for a company increases the amount of sales. The value of the correlation factor you computed is close to plus one, indicating that there is a high degree of correlation between the two sets of numbers.

At this point you can go on to perform additional statistical calculations on the mean, standard deviation and variance of the data you still have stored in your calculator. Leave your calculator on for the following example.

The slope and y-intercept have been calculated so that the line can be plotted, if desired.

[2nd] [Mean] — This sequence can be used to compute the mean value of "y" data points.

[CPT] [2nd] [Mean] — This sequence can be used to compute the mean value of "x" data points.

Example: In the previous example, compute the average number of sales people (mean value of "x") and the average amount of sales (mean value of "y").

Press	Display/Comments	
[2nd] [Mean]	115.5	Average amount of sales
[CPT] [2nd] [Mean]	7.666666667	Average number of people

(Leave your calculator on for the following example.)

[2nd] [S.D.] — This sequence can be used to compute the standard deviation of "y" using n-1 weighting.

[CPT] [2nd] [S.D.] — This sequence can be used to compute the standard deviation of "x" using n-1 weighting once the (x, y) points are entered.

Example: Continuing with the same example, calculate the standard deviation for the number of sales people and for the amount of sales.

Press	Display/Comments	
[2nd] [S.D.]	29.57532756	Standard deviation for amount of sales
[CPT] [2nd] [S.D.]	3.444802849	Standard deviation for sales people

[2nd] [VAR] — This sequence can be used to determine the *variance* of "y" using N weighting.

[CPT] [2nd] [VAR] — This sequence can be used to determine the *variance* of "x" using N weighting once the (x, y) points are entered.

Example: Determine the variance of "x" (the number of sales people) and the variance of "y" (the amount of sales) for the NoDie Life Insurance Company. Note that it is not necessary to reenter the data points; simply press the appropriate key sequences.

Press	Display/Comments	
[2nd] [VAR]	728.9166667	Variance for the amount of sales
[CPT] [2nd] [VAR]	9.888888888	Variance for the number of sales people

Trend Line Analysis

Trend line analysis is a variation of linear regression that's very handy in making predictions based on trends or growth. There are special features in your calculator that provide for easy and rapid trend line predictions.

The only thing that makes trend line analysis different from linear regression is that the "x" values are automatically increased by 1 for each data point. Your calculator does this for you all by itself — all you need to do is enter the first "x" value with the [x⇌y] key, and then enter consecutive "y" values with the [Σ+] key. Your machine will automatically increment the "x" variable by one for each "y" value you enter.

Once all your data is entered, you've got all of the information at your fingertips that was available in the linear regression calculation. Your calculator draws the "best fitting line" through the data. You can use the calculator to:

- Predict a "y" value for any "x" you select. Enter "x", press [2nd] [y']
- Predict an "x" value for any "y" you select. Enter "y", press [2nd] [x']
- Calculate the slope of the line: Press [2nd] [SLPE]
- Calculate the intercept of the line: Press [2nd] [INTCP]
- See how well the data points are related. Press [2nd] [CORR]

Example: Dates Unlimited, a computer dating service, has the following annual profits:

Year (x values)	1962	1963	1964	1965 - 1970
Profit in millions (y values)	−2.1	−0.3	0.8	inactive
Year (x values)	1971	1972	1973	1974
Profit in millions (y values)	2.9	2.8	3.6	4.0

What profit can be expected in 1980 and when will the company break the $10 million mark? Note: There is no guarantee that the actual profits will follow the pattern; business conditions may change. Your predictions assume that current trends will continue.

Press	Display/Comments	
[2nd] [CM]	0	Clears memories
1962 [x:y]	0.	Enter the first "x" value
2.1 [+/-] [Σ+]	1.	Enters the 1962 loss
	Since the next "x" value is to be incremented by 1 (to 1963) you won't need to enter it.	
.3 [+/-] [Σ+]	2.	1963 loss
.8 [Σ+]	3.	1964 gain
	You don't want the next x value to be 1965, so enter the value you want (1971)	
1971 [x:y]	1965.	Display shows the x value not used.
2.9 [Σ+]	4.	1971 gain
2.8 [Σ+]	5.	1972 gain
3.6 [Σ+]	6.	1973 gain
4 [Σ+]	7.	1974 gain
1980 [2nd] [y']	6.52179844	Millions of profits expected in 1980
10 [2nd] [x']	1988.297875	Year when profits are predicted to be $10 million.

In 1980 the company is projected to earn $6.52 million and to reach the $10 million mark early in the second quarter of 1988.

IV. PROGRAMMING KEYS AND EXAMPLES

Computers are having such an impact on everyday life that we've become familiar with terms such as "computer-programmers," "programming the computer," or just plain "programming." For some people, these terms conjure up visions of super-sophisticated individuals dealing in a highly complex field and just the thought of becoming a "programmer" is beyond the realm of possibility, at least without a great deal of training.

Nothing could be further from the truth. In fact, "programming" with your calculator is simple; and most intriguing is the fact that anyone can be "programming" after a couple of easy lessons. Texas Instruments designed its programmable calculators to make programming simple and easy—versatile enough that a loan officer at a bank, a forecast analyst, an astute businessman, a real estate broker, a business student or someone using just basic arithmetic can find solutions to his problems quickly and easily. The calculating power is there for everyone, but you need use only what is required for your application. It will be amazing how quickly and easily previously time-consuming problems can be solved with simple arithmetic and simple programs. In solving problems on your calculator, you basically determine a sequence of operations and functions needed to give you the solution to that problem. For instance, you can manually perform the calculation 1 + .15 = ? by entering the numbers and pressing the appropriate function keys ([+] and [=]). Programming is little more than pressing [2nd] [LRN], which puts your calculator in what we'll call "learn mode," and telling the calculator to remember the sequence in which you press the keys to arrive at the correct result. What actually happens is that each keystroke is stored in your calculator, and each has become a *program instruction*. The series of keystrokes (instructions) is now a *program*. When the instructions of the program are performed, they produce the same result as the equivalent manual keystrokes. Once stored, this program can be exercised again and again by supplying new sets of variables instead of pressing the program keystrokes. This not only saves you a great deal of time, but also decreases the chances of making an error.

A Quick Programming Example

To get started programming, let's look at the following situation. (After this quick example to get you started, we'll go through the process in step-by-step fashion.) Assume that you want to determine the sale price of several items in a store. You know that all are marked down 35%.

Without programming, here's how you could calculate the sale price (at a 35% discount) of an item regularly costing $25.95.

Press	Display/Comments	
[CLR] [2nd] [Fix] 2	0.00	Clears and fixes decimal at 2 places
25.95	25.95	Enters the regular price
[−] 35 [%] [=]	16.87	Calculates the discount and evaluates the sale price.

To find the sale price of another item, you'd enter the regular price into the display and press [−] 35 [%] [=] again. The keystroke sequence [−] 35 [%] [=] is repeated for each item. A program can "press" these keys for you.

Follow with us as we set up a program to solve this problem, to get a feel for what's going on. After this example we'll go back and explain the process of programming your calculator in more detail.

***Programming It** — Entering a program:*

Press	Display/Comments	
[2nd] [CA] [2nd] [FIX] 2	0.00	Clears the calculator completely and fixes decimal at two places. You want the calculator to remember some keystrokes, so tell it to get ready to "learn" them.
[2nd] [LRN]	00 00	The display reverts to a special "learn mode display" to tell you it is ready to learn. Now press the keys you want the calculator to remember for you.
[−] 35 [%] [=]	05 00	The display tells you that the next step you can program is step 05. (You can program up to 32 steps.)
	At this point your program is complete, so tell the calculator to stop by pressing the run/stop key [R/S].	
[R/S]	06 00	Step 06 is next.
	The calculator has learned the steps and is ready to leave learn. (Pressing [2nd] [LRN] again leaves learn.)	
[2nd] [LRN]	0	

Running Your Program:

Press	Display/Comments	
	When we left learn, the next step was 06 00. The calculator learned the keystrokes in steps 00, 01, 02, 03, 04 and 05. To get back to step 00, press the reset key [RST].	
[RST]	**0.00**	Now you're ready to run it. Enter the regular price.
25.95	**25.95**	Regular price. Start the program (the keys [−] 35 [%] [=] will be pushed for you and the program will stop at step 05).
[R/S]	**16.87**	Sale price.

Now what's in all this for you? Well, from now on in to find other sales prices, you just enter the regular price and press [RST] and [R/S].

For example, compute the sale price of items costing 124.57, 201.22 and 3.95.

124.57 [RST] [R/S]	**80.97**
201.22 [RST] [R/S]	**130.79**
3.95 [RST] [R/S]	**2.57**

It's that easy!

Now let's review each of these keys on your calculator especially dedicated to helping you write and control programs.

Programming Keys

[2nd] [LRN] **The Learn Mode Key** — Pressing the sequence [2nd] [LRN] one time puts the calculator in what we'll call the "learn" mode of operation. This allows you to begin writing a program into program memory which is remembered by the machine and can be run later. Pressing the sequence [2nd] [LRN] again takes the calculator out of the learn mode. (The display is cleared when you leave the learn mode.)

When you enter the learn mode the display changes to a unique new format:

00 00

The two digits on the left tell you the program step number you are working on. As you are programming the machine these two digits will always indicate the number of the *next* available program step. (The rightmost digits will be zeros as you program the machine.) Thirty-two program steps (numbered 00 through 31) are available for your use.

The right two digits in the display will be zeros as you program the machine. As you'll be seeing in a moment, these two digits will tell you which keystroke is at each program step when you review your program with the [SST] key. The keystrokes will be indicated by a two-digit code representing the row and column number of the key. (More on this later.)

[R/S] **The Run/Stop Key** — When your calculator is *out* of learn mode, the [R/S] key is the start/stop switch for any program you may have in the machine. If the program is stopped, pressing [R/S] will start it running. If the program is running along, pressing [R/S] will stop it. The [R/S] key can also be put in a program where you want the calculator to stop. The calculator will run through your program steps until it comes to an [R/S] instruction, at which point it will stop.

[RST] **The Reset Key** — In order for you and your calculator to be able to keep track of your programming steps, they are numbered sequentially from 00 to 31. This is accomplished with what is called a "program counter." The [RST] key instructs the calculator to reset the program counter to location 00. Pressing [RST] takes you back to the beginning of your program.

[2nd] [SST] **The Single Step Key Sequence** — When you press this key sequence while your calculator is in "learn" mode, you step through your program one step at a time. This allows you to check on the keystrokes in any program you've entered, as we'll discuss below. When [2nd] [SST] is pressed when *out* of "learn" mode, you step through your program one step at a time, performing each operation separately.

To see the [2nd] [SST] key sequence in action, let's quickly go back and key in the simple program we used previously to compute price markdowns:

Press	Display/Comments	
[2nd] [CA] [2nd] [FIX] 2	0.00	Clears machine, fixes decimal at 2 places.
[2nd] [LRN]	00 00	
[−] 35 [%] [=] [R/S]	06 00	
[2nd] [LRN]	0	

Now go back and review this program using the [2nd] [SST] key sequence, just perform the following keystrokes:

Press	Display/Comments
	Reset and enter learn.
[RST] [2nd] [LRN]	00 65 Step 00
[2nd] [SST]	01 03 Step 01
[2nd] [SST]	02 05 Step 02
[2nd] [SST]	03 31 Step 03
[2nd] [SST]	04 85 Step 04
[2nd] [SST]	05 42 Step 05
[2nd] [SST]	06 00 Step 06 Unprogrammed steps
[2nd] [SST]	07 00

(Leave your calculator on for the next example)

Notice that four digits appear in the display. The left two digits tell you the program step number. The right two digits are a code that tells you what keystroke that step executes when the program runs.

Key Codes

The key code your calculator uses to indicate each step is a fairly straightforward one. The two digits simply represent the row and column respectively of the key in question (except for the number keys [0] through [9] which are represented by their number; 05 represents [5], etc.). For second functions on your calculator, the keycodes for the column are 6, 7, 8, 9, and 0 rather than 1 through 5, as shown in the diagram below.

Rows

Code for [2nd] [√x] is 19.

31 (row 3 column 1 is [%])

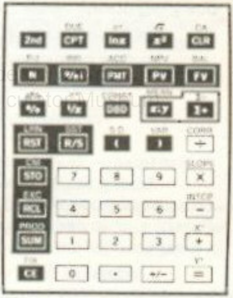
42 (row 4 column 2 is [R/S])

08 (number key [8])

65 (row 6 column 5 is [−])

03 (number key [3])

85 (row 8 column 5 is [=])



Rows: 1 2 3 4 5 6 7 8

Columns	1	2	3	4	5
Column numbers for second functions	6	7	8	9	0

See Appendix B for a complete list of key codes.

The display **00 65** tells you that step 00 is [−], display **01 03** tells you that step 01 is [3], etc. All of the keys used in your program are displayed with their key codes when you single step through your "learn mode". You can check to see if your program is entered properly using this method.

If a step is not entered correctly (or you want to change it) you can enter a new keystroke at any step by simply keying it in. A new keystroke will write over and replace any step that's there. (The display will then move on to the next step.)

NOTE: When entering the second function keys, pressing [2nd] and then the desired second function uses only *one* of your 32 allowable program steps.

Let's go back and modify the program you now have in the calculator to discount 25% instead of 35% (change the 3 to a 2). (Notice: At this point your calculator may have switched over to its power saving display — pressing [2nd] [2nd] restores the display — even in the learn mode.)

Press	Display/Comments	
[2nd] [LRN]	0	Leaves learn
[RST]	0.00	Returns to step 00
[2nd] [LRN]	00 65	Enters learn mode.
	Now we'll single step to the 3 and change it to a 2.	
[2nd] [SST]	01 03	This is the step we want to change to a 2.
2	02 05	The 2 has replaced the 3 in step 01 and the calculator has moved on — showing the contents of step 02.
[2nd] [LRN]	0	Leaves learn

Now the program discounts 25% instead of 35%. (Leave the calculator on for the next example.)

We can now use our modified program to calculate the sale price (25% discount) of an item regularly costing 25.95.

[RST]	**0.00**	Resets to step 00
25.95	**25.95**	Enters the regular price
	Now start the program	
[R/S]	**19.46**	The sale price is $19.46

Using the Reset Key — [RST] — Inside a Progam

When [RST] is entered as a program step, it tells the calculator to return to step 00. By placing an [RST] instruction right in your programs, you can eliminate the need for pressing [RST] each time you use the program.

Let's write a program to discount the number you enter in the display by 25%. This time to use the program all you want to do is enter the regular price and press [R/S]. You want the calculator to then compute the discounted price and stop, and have it reset automatically for the next calculation. Here's how you can do it.

Entering Your Program:

Press	Display/Comments	
[2nd] [CA] [2nd] [FIX] 2	0.00	Clears and fixes decimal at two places.
[2nd] [LRN]	00 00	Enters learn
	When running the program you'll enter the regular price here.	
[−] 25 [%] [=]	05 00	Enters program you want.
[R/S]	06 00	Tells calculator to stop.
	After running the program once the program counter would stop at this [R/S] instruction.	
	When running the program a second time you'd enter the price you want discounted here.	
	Now you can tell the calculator to reset to the beginning and continue running with [RST]	
[RST]	07 00	
	Now leave learn and reset for the first calculation.	
[2nd] [LRN] [RST]	0.00	

Running Your Program: To use this program to find the sale price of items costing 25.95, 15.42, and 17.87, just enter the regular price of each item and start the program.

25.95 [R/S]	**19.46**	Sale price
15.42 [R/S]	**11.57**	
17.87 [R/S]	**13.40**	

You could continue using this program for as many items as you needed to discount.

Programming With Financial/Business/and Statistics Keys

The real power of programming with your calculator becomes apparent when you realize that any of the calculator's keys or second functions can be used as part of a program, except one. **You cannot use the key sequence [2nd] [IRR] (Internal Rate of Return) as part of a program.** This is such a complex calculation that it uses most of the calculator's internal memories and registers, not allowing enough room for a stored program. With this exception, all of your calculator's financial, business and statistical keys can be used as program steps. This brings you an added dimension in problem solving, since even a simple program with a few steps can perform many powerful computations for you.

Profit Margin — An example of using *Memory* operations as program steps.

There are many occasions when you will need to use a number more than once as part of a program. To have the number available for use repetitively, you can store it in a memory the first time you use it, and then recall it whenever needed later on.

For example, in the formula:

$$\text{Profit Margin} = \frac{\text{Selling Price} - \text{Cost}}{\text{Selling Price}} \times 100$$

the selling price is used twice.

First let's use this formula *without* a program to calculate the profit margin on an item which sells for \$65.25 and cost \$32.40.

$$\text{Profit Margin} = \frac{65.25 - 32.40}{65.25} \times 100$$

Press	Display/Comments	
[2nd] [CA] [2nd] [Fix] 2	0.00	Clears calculator completely and fixes decimal to 2 places.
65.25 [STO] 0	**65.25**	Enters selling price and stores in memory 0. (Store it since you'll need to divide later.)
[−] 32.40 [=]	**32.85**	Evaluates 65.25 − 32.40
[÷] [RCL] 0	**65.25**	Recalls selling price for division.
[×] 100 [=]	**50.34**	Profit margin in %.

Now, let's write a simple program that would allow you to evaluate profit margin easily and rapidly for quite a number of different products.

Let's assume that you want to write a program that allows you to enter the selling price, press [R/S], enter the cost, press [R/S] once more, and the calculator displays the profit margin.

Keying in your program:

Press	Display/Comments	
[2nd] [CA] [2nd] [FIX] 2	0.00	Clears everything and fixes decimal at two places.
[2nd] [LRN]	00 00	Enters learn
	When running the program you'll enter the selling price into the display at this point, and press [R/S].	
[STO] 0 [R/S]	Stores the selling price in memory 0 and stops.	
	When running the program you'll enter the cost into the display at this point and press [R/S].	
[STO] 1	05 00	Stores the cost.
	Now evaluate $\frac{\text{Selling Price} - \text{Cost}}{\text{Selling Price}} \times 100.$	
[RCL] 0 [−] [RCL] 1 [=]	11 00	Evaluates Selling Price — Cost.
[÷] [RCL] 0	14 00	Divides by selling price.
[×] 100 [=]	19 00	Multiplies by 100 and evaluates profit margin.
[R/S]	20 00	Stop to see the results.
[RST] [2nd] [LRN] [RST]	0.00	Place reset in the program and leave learn. Reset for the first calculation.

Running your program: Let's find the profit margin on the following items.

Item	Selling Price	Cost
Item 1	56.53	28.32
Item 2	45.00	29.95
Item 3	78.95	32.50

Press		Display/Comments	
56.53 [R/S]	28.32 [R/S]	**49.90**	Profit margin on item 1
45.00 [R/S]	29.95 [R/S]	**33.44**	Profit margin on item 2
78.95 [R/S]	32.50 [R/S]	**58.83**	Profit margin on item 3

With these basics on how to program your calculator, you can go on to build programs to suit your own problem solving needs. In subsequent chapters we'll delve deeper in how to solve problems in business, finance and statistics on your calculator, using programs where appropriate.

By way of review, you might find it helpful to follow these general steps as you build your programs and enter them into your calculator.

1. In the calculate mode, press [RST] or [2nd] [CA]. Either sequence positions the program counter to 00, the first location of program memory. The [2nd] [CA] sequence also clears the program memory. Note: if you are in learn you'll have to leave learn before you can clear the program — or you turn the machine OFF then ON.
2. Press [2nd] [LRN] to place your calculator in the learn mode. The special four-digit display **(00 00)** identifies this mode.
3. Key in your program completely.
4. Make sure your program did not exceed the program memory size of 32 steps. When location 31 is filled the calculator automatically switches to the calculate mode where the special four-digit display is conspicuously absent.
5. Switch from the learn mode to the calculate mode by pressing [2nd] [LRN] again.
6. Run a test problem of known results and correct your program as required.

Note: An error condition encountered when running a program will cause the progam to halt.

V. MORE ON INTEREST DISCUSSION AND EXAMPLES

The occurrence of interest is found throughout the financial world. Interest is the "rent" paid for the use of someone else's money. Interest can be the money your savings account earns, paid by the bank that is using your money, or money that you pay for a car loan.

Interest is also a factor when looking at investments. Today's money will have a different value at some future date because of its interest drawing potential. Conversely, some future sum of money must be discounted when making judgments concerning its value today.

The amount of interest involved in any given financial situation will in general depend on four factors:

1. The amount of money involved (called principal).
2. The interest rate (usually expressed as a percentage).
3. The length of time the money is borrowed or loaned.
4. The type of interest (or the way the interest is computed).

There are two basic types of interest: **simple** and **compound.** There are also two basic ways of stating interest rates: **nominal** and **effective.** We'll explore these definitions and then show a method for converting between the most common rates you'll encounter.

Simple Interest

When simple interest is applied, only the initial amount of money earns interest. No additional capital is added to the account by deposit or by retaining any interest earned previously. Simple interest is the product of three variables.

Interest earned (I) = Principal (P) × interest rate (r) × number of periods (t)

or, $I = P\,r\,t$

Example: If you deposited $2000 in a fund that guarantees 12% simple interest per year, how much interest would you draw in 3 years?

Press	Display/Comments	
2000 [×]	**2000.**	Principal times
12 [%] [×]	**240.**	Amount of interest each year
3 [=]	**720.**	Total interest for 3 years

Your $2000 investment will return $720 in interest.

Discount (Present Value vs Future Value)

The total amount for the above problem is equal to the principal plus the interest or $2000 + $720 = $2720. The principal amount is actually a *present value* and the total amount is a *future value* because time has passed and interest has been generated. When you are considering some future value, its present value can be determined for a simple interest situation using the equation:

$$P = \frac{S}{1 + rt}$$

where P is the present value, S is the future value, r is the interest rate, and t is the period of time.

Example: What is the present value of a $3000 bond at 7% simple interest that matures in 9 months? The face value of the bond ($3000) must be discounted to the present.

$$P = \frac{3000}{(1 + (7\% \times 9/12))}$$

Press	Display/Comments	
3000 [÷]	**3000.**	Enters S (future value).
[(] 1 [+] [(] 7 [%] [×]	**0.07**	
9 [÷] 12 [)] [)] [=]	**2850.356295**	Calculates P (present value).
[2nd] [fix] 2	**2850.36**	Rounds to 2 decimal places.

This problem could have been rephrased to read "How much should you invest now at 7% simple interest to accumulate $3000 in 9 months?" The answer is $2850.36.

Exact and Ordinary Simple Interest

When computing simple interest, you should be aware of several different methods of measuring time and how they affect your calculations. Exact simple interest is based on the exact number of days in a year, whereas ordinary simple interest uses a fixed 360-day year. The interest earned for part of a period in any simple interest situation is based directly on the part of the period that is used.

Example: Calculate the exact and ordinary interest on $3000 for 60 days at an annual percentage rate (APR) of 7%.

For exact: Interest = P r t = 3000 (7%) (60/365)

Enter	Display/Comments	
[2nd] [Fix] [2]	Fixes decimal at two places.	
3000 [×]	**3000.00**	Enters principal.
7 [%] [×]	**210.00**	Enters r.
60 [÷] 365 [=]	**34.52**	Enters time (fraction of a year. 365 days in a year) and evaluates interest.

For ordinary interest: I = P r t = 3000 (7%) (60/360)

Press	Display/Comments	
3000 [×]	**3000.00**	Enters principal.
7 [%] [×]	**210.00**	Enters r.
60 [÷] 360 [=]	**35.00**	Enters time (fraction of a year, 360 days in a year) and evaluates interest.

In the same manner, the number of days per month used in calculations can be exact or fixed at 30 days. You'll have to check with the institution involved to be sure which method is used.

Compound Interest

Most investment situations involving interest compound the interest earned to the principal for each interest period. Now, the interest earned in one period will itself become principal and earn interest during the following period.

In the previous examples, if the interest was *compounded annually*, the total investment gain would be significantly increased because the interest earned during one year would be drawing interest the next.

Four values are used in compound interest calculations: the number of periods, N, the periodic interest rate, i, the present value, PV, and the future value, FV. As explained in the section on *Financial and Business Functions*, once you've entered any three of these values into your calculator, you can determine the fourth by pressing [CPT] followed by the key representing the unknown fourth value.

Example: The house you bought for $37,075 in 1972 was appraised at $52000 in 1977. What was the average annual appreciation rate?

Press	Display/Comments	
[2nd] [CM] [2nd] [FIX] 2	Clears memories and fixes decimal at two places.	
37075 [PV]	**37075.00**	Enters present value.
52000 [FV]	**52000.00**	Enters future value.
5 [N]	**5.00**	Enters number of years.
[CPT] [%i]	**7.00**	Computes annual appreciation.

The average annual appreciation in the value of your house is about 7%.

Example: You plan to travel to Europe in two years. How much do you need to invest today at 7.5% annual interest compounded daily to have $3500 in two years? (In this example you know the future value, and are solving for the present value.)

Press	Display/Comments	
[2nd] [CM] [2nd] [Fix] 2	Clears memories and sets it to display 2 decimal places.	
3500 [FV]	3500.00	Enters future value.
7.5 [÷] 365 [=] [%i]	0.02	Calculates and enters daily i (rounds to 2 places in the display).
365 [×] 2 [=] [N]	730.00	Calculates and enters the number of compounding periods.
[CPT] [PV]	3012.52	Computes the present value.

You need to invest $3012.52 today in order to have $3500 in 2 years.

Nominal Rates — The Method Used in This Book

You'll often see interest rates specified as an annual rate with daily, monthly, quarterly, or semiannual compounding. For instance, 6% annual interest compounded monthly (when stated in the USA) usually means 6% **nominal** annual interest compounded monthly.

Nominal interest rates do not tell you the exact **annual** interest rate; they tell you the interest rate for the compounding period. A nominal interest rate of 6% annual interest compounded **monthly** means that the **monthly interest rate** is 6% divided by the number of months in a year (that's a rate of 6%/12 monthly interest, or 0.5% monthly interest). The nominal interest rate "6% annual interest compounded quarterly", means that the quarterly interest rate is 6%/4 (or 1½% each quarter).

Effective Rates

Effective interest rates can be used in calculations. An effective rate is the rate you actually earn or pay for the period of time stated. Interest rates stated as 1% monthly interest, 2% quarterly interest, etc., are usually effective rates. In all cases involving interest, if there is any doubt in your mind about the terminology, check with the lending agency involved.

Converting From One Type of Interest to Another.

What if you are given a monthly interest rate, and you need to know the semiannual rate, or the yearly rate?

Your calculator can make these otherwise very difficult conversions easily. Here's how you can do it:

1. At the given interest rate find the value of $1 after 1 year.
2. You need the interest rate for a given interval. At this point you enter the number of those intervals in one year.
3. Press [N] [CPT] [%i].

Let's consider a few examples:

Example 1: Monthly to Semiannual Rate. You're told that the interest rate is "11% annual interest compounded monthly." What is the equivalent semiannual interest rate?

Press	Display/Comments	
	Step 1:	
[2nd] [CM]	Clears memories.	
11 [÷] 12		
[=] [%i]	0.916666667	Monthly interest.
12 [N]	12.	Number of months in a year.
1 [PV]	1.	Enter $1 as the present value.
[CPT] [FV]	1.115718837	This is the value of $1 at the end of one year at the given interest rate.
	Step 2:	
2	2	The number of time intervals in a year for the semiannual interest rate you need.
	Step 3:	
[N] [CPT] [%i]	5.62759284	The semi-annual percent interest.

Example 2: Nominal to Effective Yearly Interest. The interest rate on savings is 6% nominal annual interest compounded monthly. What is the equivalent annual rate (the effective annual rate)?

Press	Display/Comments	
	Step 1:	
[2nd] [CM]	Clears memories.	
6 [÷] 12 [=] [%i]	0.5	Monthly interest given.
12 [N]	12.	Number of months in one year.
1 [PV]	1.	Enters $1 as the present value.
[CPT] [FV]	1.061677812	This is the value of $1 at the end of one year at the given interest rate.
	Step 2:	
1	1	The number of time intervals in a year for the interest you need.
	Step 3:	
[N] [CPT] [%i]	6.1677812	The effective annual rate is about 6.17%.

Example 3: Your bank pays 5¼% annual interest compounded daily. Since you make monthly payments you'd like to know the monthly rate.

Press	Display/Comments	
	Step 1:	
[2nd] [CM]	Clears memories.	
5.25 [÷] 365		
[=] [%i]	.014383562	Daily interest.
365 [N]	365.	Number of days in a year.
1 [PV]	1.	Enters $1 as present value.
[CPT] [FV]	1.053898581	Amount $1 is worth at the end of one year.
	Step 2:	
12	12	
	Step 3:	
[N] [CPT] [%i]	0.43842681	Percent monthly interest.

NOTE: If you convert an interest rate to a shorter time interval, you may not receive all the interest you calculate! For example, when a quarterly interest rate is specified for a saving account, you may not earn any interest until the quarter is completed. An equivalent monthly rate would lead you to believe that you would earn interest after one month, but in reality the bank may only give you the interest at the end of the quarter.

VI. ANNUITIES — DISCUSSION AND EXAMPLES

An annuity is any series of equal payments made at regular intervals of time. The time intervals between payments are called payment periods. An annuity is a compound interest situation with equal periodic payments.

An **ordinary annuity**, sometimes called payment in arrears, involves payments made at the end of each payment period. Most loans fall into this category.

Insurance premiums and rent payments are examples of **annuity due** situations (also called payments in advance). Regular deposits made at the beginning of each period into a savings account form an annuity due type of investment.

The variables involved in annuity calculations are:

PV = Present value of a debt or an account

PMT = Payment per period

i = Interest rate for payment period (remember to convert to the periodic interest rate)

N = Number of periods

FV = Future value of a debt or an account.

There is a separate key for each of these variables on your calculator. Enter any 3 of these unknowns by pressing the proper key after each value. For ordinary annuities press [CPT] and the key for the unknown and that unknown is calculated. For annuity due situations, press [2nd] [DUE] and the key for the unknown.

Ordinary Annuities

When you take out a loan, you establish a debt of some present value to be repaid with interest by equal payments for a fixed number of periods. Following is an example showing how to calculate the number of monthly payments.

Example: How long will it take to pay off a $32,000 loan at 8.75% if your monthly payments are $400? How long if the monthly payments are $300?

Press	Display/Comments	
[2nd] [CM] [2nd] [FIX] 2	Clears memories and fixes decimal at 2 places.	
32000 [PV]	32000.00	Enters loan amount.
8.75 [÷] 12 [=] [%/i]	0.73	Calculates and enters monthly interest.
400 [PMT]	400.00	Enters payment amount.
[CPT] [N]	120.50	You'll have to make $400 payments for over 120 months. To find how much you'll owe after the 120th payment:
120	120.00	Enters the number of complete payment periods.
[2nd] [BAL]	199.50	The remaining balance.
	You'll pay the loan off completely if your 120th payment is $400.00 + 199.50 or 599.50.	
	Now find out how long it will take to pay off the loan if you make $300 payments.	
300 [PMT]	300.00	

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Press	Display/Comments	
CPT N	207.02	You'll have to make $300 payments for 207 months and then you'll still owe some on the loan. To find out how much you'll still owe after the 207th payment:
207 2nd BAL	7.35	Your 207th payment will be $300 + $7.35 or $307.35 in order to retire the entire loan amount.

Notice that only the $300 payment needed to be reentered for the second part of the problem solution. The previously entered values were retained.

Sinking Funds

To accumulate money to meet some anticipated debt, you can establish a sinking fund (equal periodic payments earning interest) that will produce the necessary amount of money at the time of need. This is a type of *ordinary annuity* that also applies to situations such as bonds where an initial amount of money received is to be paid back at some future date.

Example: A $160,000 bond to build 20 tennis courts in the city park is to be repaid in 10 years. A fund is established where quarterly payments to retire the bond will accumulate at 5% interest (compounded quarterly). How much should each payment be?

Press	Display/Comments	
[2nd] [CA] [2nd] [Fix] 2	Clears memories and sets calculator to display two decimal places.	
160000 [FV]	**160000.00**	Enters future value.
10 [×] 4 [=] [N]	**40.00**	Number of periods (quarters).
5 [÷] 4 [=] [%i]	**1.25**	Quarterly interest rate.
[CPT] [PMT]	**3107.43**	Amount of each payment.

Reducing a Loan

Your calculator makes it easy to check on a loan situation before its termination to determine how long it will take to reduce the loan to a certain level or to find out how much has been paid after a certain length of time.

Example: How many months will it take for your $32000 loan at 8.5% yearly interest compounded monthly to be reduced to $15,000? Your monthly payments are $300.

Press	Display/Comments	
[2nd] [CM] [2nd] [FIX] 2	Clears memories and sets decimal at two places.	
32000 [PV]	32000.00	Enters loan amount.
8.5 [÷] 12 [=] [%i]	0.71	Calculates and enters monthly interest.
300 [PMT]	300.00	Enters payment amount.
[CPT] [N]	199.59	Number of months (payments) to pay out $32,000.
[÷] 12 [=] [STO] [0]	16.63	Number of years to pay out $32,000 stored for later use

Now determine the time that would be needed to pay out the $15,000 balance and take the difference.

Press	Display/Comments	
15000 [PV]	15000.00	Enters $15,000 as the PV.
[CPT] [N]	61.94	Number of months to pay out $15,000
[÷] 12 [=]	5.16	Number of years to pay out $15,000
[+/−] [+] [RCL] [0] [=]	11.47	Subtracts the number of years needed to pay off $15,000 from the number of years needed to pay off 32,000. It will take about 11.5 years to reduce the loan to $15,000.

Note that the interest rate and payment do not need to be reentered as the calculator saves the values from the previous problem.

Balloon Payments

There are many financial situations that involve not only a series of payments, but also a payment at termination that is larger or smaller than the regular payments. These are often called balloon payments or "balloons." Balloons are involved in situations where you decide to pay off a loan before its normal duration is complete, or for situations like the ownership of property, from which you have received a steady flow of rent, then decided to sell, producing a large impulse of income at the end of the investment. For either situation, payments are made at regular time intervals with a different payment, usually larger, made to terminate the transaction.

Some problems of this type can be solved using the method discussed under "Reducing a Loan."

Example: Good old dad has agreed to pay the last $600 on the loan for his son's first automobile. The boy has agreed to make $85.50 monthly payments on the $2100 automobile to repay the 9.6% loan (annual interest compounded monthly). How many payments does the son have to make? First, we'll solve for the total number of payments to pay off the loan *without* the $600 balloon.

Press	Display/Comments	
[2nd] [CM] [2nd] [FIX] 2	Clears memories and fixes decimal at 2 places.	
2100 [PV]	**2100.00**	Enters present value.
9.6 [÷] 12 [=] [%i]	**0.80**	Calculates and enters monthly interest rate.
85.5 [PMT]	**85.50**	Enters payment.
[CPT] [N]	**27.46**	Number of payments to pay off entire $2100.
[STO] [0]	**27.46**	Store in memory 0.

Next find out how many payments are eliminated by the $600 balloon and take the difference.

Press	Display/Comments	
600 [PV]	600.00	Enters balloon present value.
[CPT] [N]	7.25	Payments to pay off $600.
[+/−] [+]		
[RCL] [0] [=]	20.20	Subtracts from total payments to compute number of payments the son has to make.

Computing Rate of Return for an Annuity with a Balloon:

One powerful problem solving feature of your calculator allows you to handle rate of return problems that include a present value, a series of payments, **and** a balloon payment. Your calculator is equipped to compute the interest rate that makes the discounted sum of the present value of the payments, **plus** the present value of the balloon, equal to the PV you enter.

Here's an example: Your old Uncle Charlie calls you on the phone, complaining that he needs some ready cash — but he has a great deal for you! He has sold a parcel of land and is holding the mortgage himself. He receives $250 a month and will continue to do so for ten more years. Then he'll receive a lump sum balloon payment of $5000. Here's the deal. He'll sell all of this to you for only $29,000! The question is: Is this a good deal for you? What rate of return will you realize? You compute the rate of return on your calculator.

Press	Display/Comments	
[2nd] [CM] [2nd] [FIX] 2	Clears memories and fixes decimal at 2 places.	
10 [X] 12 [=] [N]	120.00	Calculates and enters number of payments.
250 [PMT]	250.00	Enters payment amount.
29000 [PV]	29000.00	Enters purchase price.
5000 [FV]	5000.00	Enters balloon.
[CPT] [%i]	0.28	Monthly interest rate.
[X] 12 [=]	3.38	The yearly return on your investment is just over 3%.

Since you can do better than that at any bank, based on purely business motives, you should say, "I'm sorry, Uncle Charlie!"

NOTE: WHENEVER [%i] CALCULATIONS ARE PERFORMED ON YOUR CALCULATOR, *BOTH* THE PRESENT VALUE (PV) AND FUTURE VALUE (FV) STORED IN YOUR CALCULATOR WILL BE USED IN THE COMPUTATION. BE CAREFUL THAT *PREVIOUSLY* STORED OR COMPUTED RESULTS DO NOT CREATE ERRORS IN YOUR CALCULATION. BE SURE TO CLEAR THE MEMORIES OR ENTER ZERO FOR [PV] OR [FV] AS REQUIRED, WHEN BEGINNING THESE CALCULATIONS. (THIS IS DIFFERENT FROM THE WAY YOUR CALCULATOR HANDLES COMPUTATIONS FOR [N] OR [PMT]. IN THESE CASES, THE CALCULATOR WILL JUST ATTEMPT TO USE [PV] ONLY TO COMPUTE THE PROBLEM. IF IT FINDS THAT THE [PV] VALUE IS ZERO, IT WILL THEN USE THE [FV] VALUE STORED TO COMPLETE THE CALCULATION. IT DOES NOT USE BOTH VALUES SIMULTANEOUSLY AS IN THE [%i] COMPUTATION.)

Annuities Due

An annuity due is one in which the payments are made at the beginning of the payment interval. Annuity due situations involve the same variables as ordinary annuities, and the known variables are entered in the same manner. However, when computing the unknown variable, press [2nd] [DUE] and the key for the unknown.

Example: Future Value for Annuity Due (Savings). You plan to deposit $20 per month beginning this month in a savings account which pays 5% interest compounded monthly. If you make no withdrawals, what will the balance be after one year?

Press	Display/Comments	
[2nd] [CM] [2nd] [FIX] 2	Clears memories and fixes the decimal at two places.	
20 [PMT]	20.00	Enters payment (deposit).
12 [N]	12.00	Enters periods.
5 [÷] 12 [=] [%i]	0.42	Calculates and enters monthly interest.
[2nd] [DUE] [FV]	246.60	Future value for annuity due.

Example: Payment for Annuity Due. You are the beneficiary of a $10,000 insurance policy. You elect to receive this amount in 60 equal monthly payments with the first to be made immediately. What will the amount of each payment be if 5% interest compounded monthly is paid on the proceeds of the policy?

Press	Display/Comments	
60 [N]	**60.00**	Enters number of payments.
5 [÷] 12 [=] [%i]	**0.42**	Calculates and enters monthly interest rate.
10000 [PV]	**10000.00**	Enters present value.
[2nd] [DUE] [PMT]	**187.93**	Monthly payments.

In a similar manner, the interest rate for an annuity due can be determined. Remember, if the interest is compounded monthly, you must multiply the result for % i by 12 to obtain the nominal yearly rate compounded monthly. Note that [CPT] [%i] utilizes an iterative process to obtain the interest rate. In some calculations this process can require several seconds to complete.

VII. SOME HANDY PROGRAMS

Bonds

A bond is a financial obligation made by a corporation or government agency which pays the owner a periodic amount and also has a redemption value at some future date or maturity. The amount of each periodic payment (or "coupon") is equal to the face value of the bond times the bond interest rate per period.

Present Value of a Bond

The present value of the bond (the amount you would pay) is the present value of the series of coupon payments plus the present value of the redemption value calculated at the interest rate you desire.

Let's say you'd like a program to determine the price you should pay for a bond (PV) to earn a certain interest rate. (We'll assume that you buy the bond right after a semi-annual coupon payment.) When using the program, you'd like to be able to follow these simple steps:

- Enter the semi-annual yield you require, and press [%i],
- Enter the coupon payment per $100 of bond face value (this is actually the semi-annual interest rate the bond was sold to yield), and press [PMT],
- Enter the number of coupon payments you'll receive, press [N] — and finally,
- Press [R/S] to compute and display the price per $100 of bond face value you should pay to achieve your desired rate of return.

Entering the Program:

Press	Display/Comments	
[2nd] [CA] [2nd] [FIX] 2	0.00	Clears calculator completely and fixes decimal at two places.
[2nd] [LRN]	00 00	Enters learn.

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Press	Display/Comments	
100 [FV]	04 00	Enters $100 as the future value of the bond.
[RCL] [PMT] [STO] 0	08 00	This takes the coupon payment per $100 and stores it in Memory 0.
[CLR] [PMT]	10 00	This keystroke sequence clears the payment memory so it won't interfere with a compound interest calculation.
[CPT] [PV] [STO] 1	14 00	Calculates and stores the present value of the $100 future value of the bond.
[RCL] 0 [PMT]	17 00	Places the coupon payment per $100 back in the payment memory.
[CPT] [PV]	19 00	Computes the present value of the coupon payments per $100 of the face value of the bond.
[+] [RCL] 1 [=] [R/S]	24 00	Adds present values and stops, displaying the amount you would pay.
[RST] [2nd] [LRN] [RST]	0.00	Resets for next bond calculation, leaves learn and resets for first calculation.

Let's use the program to determine what you would pay for a bond originally issued at 6⅛% (6.125%). The bond matures in 10 years so you'll receive 20 semiannual coupon payments.

You want to make 8% annual interest compounded semiannually.

Running your program:

Press	Display	Comments
8 [÷] 2 [=] [%i]	4.00	Enters semi-annual yield you require.
6.125 [÷] 2 [=] [PMT]	3.06	Enters the amount of the semi-annual coupon payment per $100 of face value of the bond. (This equals the semi-annual interest rate in percent that the bond was originally sold to yield.)
20 [N]	20.00	Enters the number of coupon payments you'll receive.
[R/S]	87.26	The amount you would pay for the bond per $100 of face value to achieve your desired yield.

Yield to Maturity of a Bond

When making investments — whether bonds are involved or not — the bottom line upon which decisions can be made is often the true rate of return an investor receives. For bonds, the true rate of return which an investor receives on his investment is called the "yield to maturity". (This is actually the interest rate at which the present value of the redemption price you'll receive, plus the present value of all the coupon payments you'll get, equals the cost or quoted price of the bond.) This calculation can be time consuming (and error prone). With a program on your calculator, it can be carried out with the touch of a few keys.

Example: Suppose today's date is June 6, 1977, and you have a bond which has a maturity date of September 1, 1984. The coupon rate of the bond is 4½% (4.5%), and the quoted price is $87.50 per hundred dollars of bond value. You'd like to know the bond's *yield to maturity.* Based on units of $100, a coupon rate of 4.5% yields an annual coupon payment of $4.50 and a semi-annual payment of $2.25. We'll set up the program so that all you'll need to do to run it is to:

- Store $100 in memory zero (press 100 [STO] 0) as your base value,
- Enter the date of bond purchase, and press [R/S],
- Enter the maturity date, press [R/S],
- Enter the annual coupon rate, press [R/S],
- Enter the quoted price, press [R/S], and
- The display will read out the yield to maturity.

Press	Display/Comments	
[2nd] [CA] [2nd] [FIX] 2	0.00	Clears calculator completely and fixes decimal at two places.
[2nd] [LRN]	00 00	Enters learn.
	When running the program you'll enter the purchase date into the display at this point.	
[DBD] [R/S]	02 00	Starts keystroke sequence to find days between dates, and stops.
	When running the program you'll enter the maturity date into the display at this point.	
[=]	03 00	Calculates the number of days between the two dates.
[÷] 182.5 [=] [N]	11 00	Converts the number of days to the number of semi-annual periods, enters this as N, and stops.
[R/S]	12 00	
	When running the program you'll enter the coupon rate at this point. (You'll enter the annual coupon payment per $100 of face value.)	
[÷] 2 [=] [PMT] [R/S]	17 00	Converts annual coupon payment to semi-annual coupon payment, enters as [PMT], and stops.
	When running the program you'll enter quoted price at this point.	

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Press	Display/Comments	
[PV]	18 00	Enters as PV.
[RCL] 0 [FV]	21 00	Enters 100 as FV.
[CPT] [%i]	23 00	Computes semi-annual rate.
[X] 2 [=] [R/S]	27 00	Computes annual rate compounded semi-annually and stops.
[RST] [2nd] [LRN] [RST]	0.00	Resets for next bond calculation, leaves learn, and resets for first calculation.

Running your program:

Press	Display/Comments	
100 [STO] 0	100.00	First, stores $100 base value in memory zero.
6.061977 [R/S]	6.06	Enters purchase date in MM.DDYYYY format.
9.011984 [R/S]	14.49	Enters maturity date in MM.DDYYYY format.
4.5 [R/S]	2.25	Enters coupon rate (actually yearly coupon payment per $100 face value).
87.5 [R/S]	6.71	Yield to maturity (annual rate compounded monthly).

The yield to maturity for this bond is 6.71%. Using this program, entering different dates and different values, you can determine the yield to maturity for any bond.

Yield to Call:

The *call* price for a bond is the price a corporation or agency pays for a bond when the bond is called (paid off) before its maturity date. The call price is usually higher than the original redemption value of the bond because interest in the form of coupon payments does not have to be paid. Based on units of $100 the call price might be $105 or $110.

To calculate the *yield to call* using the above program, enter the call price in memory 0 and change the maturity date to the most pessimistic one on which you think the bond might be called. Then enter the coupon rate and quoted price as before; the result will be the yield to call.

Notes Concerning Bond Calculations

The approaches we've used in our programs to compute bond price and bond yield are ones commonly used in the field. However, be aware of the fact that the examples we show are specific illustrations and do not take into account *all* of the factors that may affect the bond market. Historically, bond transactions have incorporated a variety of approximations, and many different types of calculations are still in use today. Because of this, the answers using the above methods may not agree exactly with answers you'll get from all other sources.

Creating an Amortization Schedule

A debt is said to be amortized when all principal and interest have been repaid, usually by equal payments at regular intervals. It's often handy to be able to see exactly how much of each payment is going for interest, and how much for principal.

We've already seen in the *Financial and Business Functions* section of this book how (for any individual loan payment) the amount of interest and principal can be easily computed on your calculator.

- You enter the original loan amount, press [PV].
- Enter the interest rate and press [%i].
- Enter the payment and press [PMT].

Then you enter the payment number you need to know about, and press [2nd] [P/I] to calculate the *principal* and [x:y] to compute the interest. In this example we'll follow some of these same basic steps in a program to create a complete table (or amortization schedule) listing for each payment how much is interest, how much is principal, and the loan balance.

Example: Let's say you're considering the purchase of a lake house, and want all the information you can obtain on the loan payoff. The loan under consideration will be for $32,000 at an 8.5% interest rate. Your payment is $300 per month. We'll develop a program that will enable you to quickly examine a detailed amortization schedule for the loan. We'll set up the program so that you'll use it as follows:

- You'll enter the loan anount and press [PV],
- Enter the interest rate, press [%i],
- Enter the payment amount, press [PMT], and
- From then on you push [R/S] repeatedly to see:
  - — payment number
  - — interest paid
  - — reduction in principal
  - — balance remaining.

Keying in your Program:

Press	Display/Comments	
[2nd] [CA] [2nd] [LRN]	00 00	Clears everything and enters learn.
	We'll use memory 0 to generate the payment numbers.	
1 [SUM] 0 [RCL] 0 [R/S]	06 00	Adds one to memory 0 each time the program loops through — then displays the results showing 1, 2, 3 ...
[2nd] [P/I]	07 00	Calculates the principal for the payment number generated.
[x:y] [R/S]	09 00	Exchanges principal and interest and displays interest.
[x:y] [R/S]	11 00	Exchanges interest and principal and displays amount of principal paid.
	Now find the loan balance for the payment number stored in memory 0.	
[RCL] 0 [2nd] [BAL] [R/S]	15 00	Calculates and displays the balance.
[RST]	16 00	Reset for the next payment.
[2nd] [LRN] [RST]	0.	Leave learn and reset for the first calculation.
[2nd] [FIX] 2	0.00	Fix decimal at two places.

Running your Program:

Press	Display/Comments	
32000 [PV]	**32000.00**	Enters loan amount.
8.5 [÷] 12 [=] [%i]	**0.71**	Calculates and enters monthly interest.
300 [PMT]	**300.00**	Enters payment you'll make.
[R/S]	**1.00**	Loan payment #1.
[R/S]	**226.67**	Interest paid by payment #1.
[R/S]	**73.33**	Equity paid by payment #1.
[R/S]	**31926.67**	Balance remaining after payment #1.
[R/S]	**2.00**	Loan payment #2.
⋮	⋮	⋮

If you continue to press [R/S], you will develop the following amortization schedule:

Payment #	Interest	Reduction in Principal	Balance
1	$226.67	$73.33	$31,926.67
2	226.15	73.85	31,852.81
3	225.62	74.38	31,778.44
4	225.10	74.90	31,703.54
5	224.57	75.43	31,628.10
6	224.03	75.97	31,552.13
7	223.49	76.51	31,475.63
8	222.95	77.05	31,398.58
9	222.41	77.59	31,320.99
10	221.86	78.14	31,242.84
11	221.30	78.70	31,164.15
12	220.75	79.25	31,084.89

Depreciation

Almost all of the tangible assets a business has lose value or wear out as time goes by. For accounting and tax purposes, a business will usually depreciate the value of an asset over a period of years. There are three different methods commonly in use for calculating depreciation. In the example that follows we'll show the differences in these methods as they are applied to calculate the depreciation of an $18,000 computer over a 5-year time span. Assume the computer can be sold in five years for $3500. The depreciable value thus becomes $18,000 − 3500 = $14,500.

Straight-Line Method

This method depreciates items a fixed amount each year. This fixed amount is just the depreciable value, divided by the number of years of depreciation. So in our case the computer is depreciated $14,500 ÷ 5 = $2900 per year for 5 years. A depreciation schedule can be established as follows:

Press	Display/Comments	
18000 [−] 3500		
[=]	**14500.**	Depreciable value.
[÷] 5 [=]	**2900.**	Annual depreciation.
[−] [2nd] [CONST]	**2900.**	Sets up "−2900" as a constant.
18000 [=]	**15100.**	Value after 1st year.
[=]	**12200.**	Value after 2nd year.
[=]	**9300.**	Value after 3rd year.
[=]	**6400.**	Value after 4th year.
[=]	**3500.**	Value after 5th year.

The straight-line method is a simple one, and it's straightforward to apply. However, it assumes that assets lose their value steadily as time goes on. In reality, many assets lose most of their value in the first few years after they're acquired. In these cases one of the two following methods of depreciation may be more accurate.

Sum-of-the-Year's-Digits Method

Computation of the annual depreciation using this method involves the sum of the digits representing each year of life of the assets. In our computer example, the assumed life of the unit is 5 years. To compute a depreciation schedule, you'd just sum the digits 1 through 5 (1 + 2 + 3 + 4 + 5) to get 15. Now, the first year's depreciation is 5/15 of the depreciable value of the asset; the second year's depreciation is 4/15 of the depreciable value, etc.

We'll develop a program which will compute each year's depreciation, as well as the depreciated value of the asset, for each of N years. Note: before running this program we'll use a formula to calculate the sum of the digits in N years:

$$\frac{N \times (N + 1)}{2}$$

We'll set things up so that after you program your calculator, you'll use the following steps to generate a depreciation schedule:

- Enter the number of years of depreciation, press [N].
- Enter the purchase price, press [PV] and [−].
- Enter the resale price, press [=] [STO] 0.

Now calculate the sum-of-the-year's digits using the formula

$$\frac{N \times (N + 1)}{2}$$

and press [STO] 1.

Your program will be set up so that pressing [R/S] will display the amount of depreciation for the first year, and pressing [R/S] again will show the value of the asset after the first year. Pressing [R/S] a third time will display the amount of depreciation for the second year, etc.

Keying in your program:

Press	Display/Comments	
[2nd] [CA] [2nd] [FIX] 2	0.00	Clears calculator completely and fixes decimal at two places.
[2nd] [LRN]	00 00	Enters learn.
[RCL] [N] [÷] [RCL] 1	05 00	
[×] [RCL] 0 [=] [R/S]	10 00	Calculates N divided by sum-of-year's-digits times depreciable value and stops to display amount of depreciation.
[+/−] [SUM] [PV] [RCL]		
[PV] [R/S]	16 00	Subtracts depreciation (adds negative value) from the price in PV memory and stops to display the depreciated value.
1 [+/−] [SUM] [N] [RST]	21 00	Decreases the quantity (N) by 1 and loops back to repeat the program for the next year.
[2nd] [LRN] [RST]	0.00	Leaves learn and resets for first calculation.

Running your program:

Press	Display/Comments	
5 [N]	5.00	Enters the number of years of depreciation.
18000 [PV]	18000.00	Enters purchase price.
[−] 3500 [=] [STO] 0	14500.00	Calculates and enters the depreciable value.
5 [X] 6 [÷] 2 [=] [STO] 1	15.00	Calculates sum of years digits $\frac{N \times (N + 1)}{2}$ for 5 years and stores it in memory 0.
[R/S]	4833.33	1st year's depreciation.
[R/S]	13166.67	Value after 1st year.
[R/S]	3866.67	2nd year's depreciation.
[R/S]	9300.00	Value after 2nd year.
[R/S]	2900.00	3rd year's depreciation.
[R/S]	6400.00	Value after 3rd year.

(continued)

(continued)

Press	Display/Comments	
R/S	**1933.33**	4th year's depreciation.
R/S	**4466.67**	Value after 4 years.
R/S	**966.67**	5th year's depreciation.
R/S	**3500.00**	Value after 5th year.
R/S	**0.00**	Totally depreciated.

Note that this method decreases the amount of the depreciation by a fixed percentage (1/15 or 6.67%) each year.

Declining Balance Method

This method assumes that the annual decrease in the value of an asset is a constant percentage of its remaining book value at the end of each year of its life. The rate at which the value is depreciated depends on what's called a declining balance factor. The factor for *straight declining balance* is 100%. For *double declining balance*, the factor is 200%. Any factor between 100% and 200% can also be used, but the two most commonly used factors today are 150% and 200%.

In using the declining balance method, you should keep in mind that the asset can't be depreciated below its salvage value. For our computer problem, let's choose 150% as the declining balance factor. (We'll check to make sure we don't get below the salvage value at the end.)

We'll work our program so that once it's in your calculator you'll follow these steps to use it:

- Enter the declining balance factor (as a whole number), divide by the number of years of depreciation, and press [STO] 0.
- Enter the purchase price, and press [R/S]

The display at this point will show the amount of the first year's depreciation, pressing [R/S] again will show the value of the asset after 1 year. Pressing [R/S] a third time will show the second year's depreciation, etc.

Keying in your program:

Press	Display/Comments	
[2nd] [CA] [2nd] [FIX] 2	0.00	Clears everything and fixes decimal at two places.
[2nd] [LRN]	00 00	Enters learn.
	When running the program you'll enter the purchase price at this point.	
[−] [RCL] 0 [%] [R/S]	05 00	Stops to show the amount of depreciation.
[=] [R/S]	07 00	Stops to show the value at the end of the year.
[RST]	08 00	Resets to perform the calculation again for the next year.
[2nd] [LRN] [RST]	0.00	Leaves learn and resets for the first calculation.

Running your program:

Press	Display/Comments	
150 [÷] 5 [=] [STO] 0	**30.00**	Enters the declining balance factor divided by the number of years of depreciation.
18000	**18000**	Enters purchase price.
[R/S]	**5400.00**	1st year's depreciation.
[R/S]	**12600.00**	Value at end of 1st year.
[R/S]	**3780.00**	2nd year's depreciation.
[R/S]	**8820.00**	Value at the end of the 2nd year.
[R/S]	**2646.00**	3rd year's depreciation.
[R/S]	**6174.00**	Value at the end of the 3rd year.
[R/S]	**1852.20**	4th year's depreciation.
[R/S]	**4321.80**	Value at the end of the 4th year.
[R/S]	**1296.54**	5th year's depreciation.
[R/S]	**3025.26**	Value at the end of the 5th year.

As you can see, the depreciated value at the end of the 5th year is below the salvage value of $3500; therefore the full $1296.54 depreciation for the 5th year would not be allowable. There are several ways to correct this situation. A good solution is to go back to the depreciated value of the asset at the end of the 4th year and subtract the salvage value from it. The result is the allowable depreciation for the 5th year:

4321.80 [−] 3500 [=] **821.80** 5th year's depreciation.

Linear Regression — Logarithmic

The linear regression capability of your calculator allows you to find the best "straight line" approximation of the "trend" in data you may be analyzing. Sometimes, however, you will know that the data you have is not linearly related, but is related by some other function. Your calculator will allow you to normalize one or both of the variables to create a situation where the relationship is linear. When initially analyzing this type of data, you must select the type of curve that you think characterizes your particular situation and then enter the data accordingly.

Example: A city published the following census data. Based on the growth pattern shown, you'd like to predict the population for the year 2000, and the year in which the population will reach 50,000 inhabitants. Assume that the population growth is *logarithmic*.

Year	1930	1940	1950	1960	1970
Population	3591	5116	8507	15410	28612

Here's how you would enter the data in a logarithmic regression situation such as this:

- Enter the year, press [x⇌y]
- Enter the population for that year, and press [lnx] and [Σ+].
- Repeat for all data points.

Once all your data is in the calculator, to predict the population in the year 2000 simply

Enter 2000, and press [2nd] [y'] [2nd] [e^x].

(Note — you press [2nd] [e^x] to convert from logarithmic to base 10 data).

To predict when the population will reach 50,000, enter 50000 and press [lnx] [2nd] [x'].

We'll use a program to enter the data. (This will only save you one keystroke when entering each data point, but more complex functions may be handled in the same manner.) We'll design a program where you enter the year and press [R/S], then enter the population for that year and press [R/S] again. You'll just repeat this process for each data point.

Keying in your Program:

Press	Display/Comments	
[2nd] [CP] [2nd] [LRN]	00 00	Clears everything and enters learn.
	When running the program you'll enter the year at this point.	
[x:y] [R/S]	02 00	Enters the year and stops.
	When running the program you'll enter the population at this point.	
[lnx] [Σ+] [R/S]	05 00	Enters the natural log of the population and stops.
[RST]	06 00	Returns to the first for entry of the next data points.
[2nd] [LRN] [RST]	0.	Leaves learn and resets for the next calculation.

Running your Program:

Press	Display/Comments	
1930 [R/S] 3591 [R/S]	1.	Enters data for 1930.
1940 [R/S] 5116 [R/S]	2.	Enters data for 1940.
1950 [R/S] 8507 [R/S]	3.	Enters data for 1950.
1960 [R/S] 15410 [R/S]	4.	Enters data for 1960.
1970 [R/S] 28612 [R/S]	5.	Enters data for 1970.
	All 5 data points are entered. To predict the population in the year 2000:	
2000 [2nd] [y'] [2nd] [e^x]	128358.151	Predicted population
	To predict when the population will be 50,000:	
50000 [lnx] [2nd] [x']	1982.053618	About 1982.

APPENDIX A
ERROR INDICATION

The display will flash whenever the limits of the calculator are exceeded or when an improper operation is requested. Pressing [CE] removes the error indication from the display. Calculations or data entries up to that point are preserved. Pressing [CLR] not only removes the error condition, but also clears the calculation entirely, except for data stored in the memories.

A flashing display is produced for the following reasons:

1. The calculation result (in display or memory) is outside the range of the calculator, $\pm 1.0 \times 10^{-99}$ to $\pm 9.9999999 \times 10^{99}$.
2. Calculating a root or logarithm of a negative number, or raising a negative number to any power with the y^x key.
3. Dividing a number by 0, or using the key sequence 0 [2nd] [Δ%] 0 or 0 [2nd] [Δ%] n.
4. Attempting to calculate financial unknowns before enough known variables have been entered or when no valid solution exists.
5. Attempting to open more than 4 levels of processing or to have more than 15 open parentheses at any one level.
6. Linear regression calculations that deal with a vertical line, or attempt to find x' for a horizontal line.
7. Trying to use linear regression with less than two data points.
8. Multiplying a number greater than 1×10^{99} by another number (decimal or integer) may cause an error condition.
9. Pressing two function keys in succession or a memory operation key and then another function key that is not related to memory operations. For example, [RCL] [+].
10. Entering a program in the learn mode, but failing to terminate the program by pressing the run/stop key, [R/S], or the reset key, [RST].

APPENDIX B
INSTRUCTION CODES

In the learn mode, the display shows you where the program counter is positioned and the instruction presently in that location. The instruction is represented by a two-digit code that comes directly from that key's location on the keyboard, as discussed in Chapter IV.

The table below illustrates the key codes for each function.

PROGRAM KEY CODES

Key	Code	Key	Code	Key	Code	Key	Code	Key	Code
	None	DUE	17	e^x	18	$\sqrt{x}$	19	CI	10
2nd	None	CPT	12	lnx	13	x^2	14	CLR	15
P/I	26	[illegible]	*	ACC	28	NPV	29	BAL	20
N	21	%i	22	PMT	23	PV	24	FV	25
Δ%	36	y^x	37	CONST	38	Mean	39	Σ-	30
%	31	1/x	32	DBD	33	x:y	34	Σ+	35
LRN	46	SST	47	S.D.	48	VAR	49	CORR	40
RST	41	R/S	42	(	43	)	44	÷	45
CM	56		07		08		09	SLOPE	50
STO	51	7	07	8	08	9	09	×	55
EXC	66		04		05		06	INTCP	60
RCL	61	4	04	5	05	6	06	−	65
PROD	76		01		02		03	x'	70
SUM	71	1	01	2	02	3	03	+	75
FIX	86		00		83		84	y'	80
CE	81	0	00	•	83	+/−	84	=	85

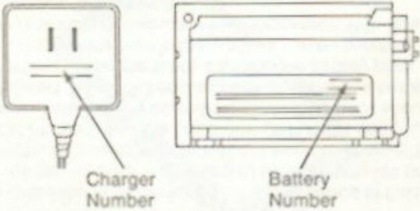
* NOTE: 2nd [illegible] does not have a valid key code and cannot be used within a program.

Through normal usage you will become familiar with the more common instruction codes so that constant reference to this table will not be necessary. The others are quickly determined by counting row and column numbers on the keyboard itself.

APPENDIX C
BATTERY AND AC OPERATION

Normal Operation

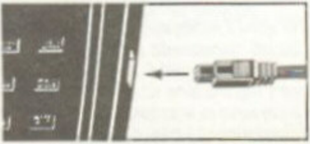
Your calculator is designed for portable operation with periodic recharging of the battery pack with the adapter/charger supplied. It is important that the proper adapter/charger is used. If replacement of the battery pack or charger becomes necessary, be sure that an exact replacement is obtained.



Your calculator uses the BP-7 with the AC9132 adapter/charger.

Caution: Use of other than the proper Adapter/Charger may apply improper voltage to your calculator and damage the unit.

To ensure maximum portable operation time, connect the Adapter/Charger to a standard 115V/60 Hz outlet, plug into calculator, and charge battery pack at least 4 hours with the calculator OFF or 10 hours with the calculator ON. The adapter/charger and battery pack may become warm when used on AC power. This is normal and of no consequence.



When the battery pack is fully charged, the calculator will operate approximately 2 to 3 hours before recharging is necessary. However, don't hesitate to connect the adapter/charger if you know or suspect the battery pack is nearly discharged. A battery pack near discharge can adversely affect all calculator operations, giving erroneous results. A discharged battery pack is typically indicated by a dim, erratic or blank display.

While individual cell life in a battery pack is difficult to predict, under normal use, rechargeable batteries have a life of 2 to 3 years or about 500 to 1000 recharge cycles.

Periodic Recharging

Although the calculator will operate indefinitely with the adapter/charger connected, the rechargeable battery pack can lose its storage capacity if it is not allowed to discharge occasionally. For maximum battery life, it is recommended that you operate the calculator as a portable at least twice a month, allowing the batteries to discharge, then recharge accordingly.

Excessive Battery Discharging

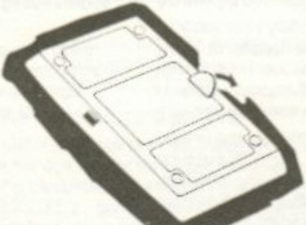
If the calculator is left on for an extended period of time after the battery pack is discharged (accidentally left on overnight, for example), connect the adapter/charger for at least 24 hours with the calculator OFF. If this does not restore normal battery operation, the battery pack should be replaced. Repeated occurrences of excessive battery discharging will permanently damage the battery pack. Spare and replacement battery packs can be purchased directly from Texas Instruments Incorporated, P.O. Box 53, Lubbock, Texas 79408.

Storage

If the calculator is stored or unused for several weeks, the battery pack will probably need recharging before portable use. The battery pack will not leak corrosive material; therefore, it is safe to store the calculator with the battery pack installed.

Battery Pack Replacement

The battery pack can be quickly and simply removed from the calculator. Hold the calculator with the keys facing down. Place a small coin in the slot in the bottom of the calculator. A slight prying motion with the coin will pop the slotted end of the pack out of the calculator. Carefully disconnect the wires that attach the battery pack to the calculator. The pack can then be removed entirely from the calculator.



The metal contacts on the battery pack (where charger and calculator plug in) are the battery terminals. Care should always be taken to prevent any metal object from coming into contact with these terminals and shorting the batteries.

To re-insert the battery pack, first attach the connecting wires to the terminals of the battery pack. Alignment should not be a problem as the connector will only fit in one position. Then, place the pack into the compartment so that the small step on the end of the pack fits under the edge of the calculator bottom. A small amount of pressure on the battery pack will snap it properly into position. (Do not force. It will fit easily when properly oriented.)

APPENDIX D
IN THE CASE OF DIFFICULTY

In the event that you have difficulty with your calculator, the following instructions will help you to analyze the problem. You may be able to correct your calculator problem without returning the unit to a service facility. If the suggested remedies are not successful, contact the Consumer Relations Department by mail or telephone (refer to *If You Need Service Information* later in this appendix). Please describe in detail the symptoms of your calculator.

Symptom	
1. Display is blank for no obvious reason.	Press and hold [R/S] momentarily. If display returns, the calculator was running a long program or operating in a continuous program loop. The battery pack may be discharged or improperly installed. Also, check to be sure the ON-OFF switch is fully in the ON position.
2. Display shows erroneous results, flashes erratic numbers, grows dim, or goes blank.	The battery pack is probably discharged or improperly connected. Refer to *Battery and AC Operation* in Appendix C.
3. Display flashes while performing keyboard operations.	An invalid operation or key sequence has been pressed or the limits of the calculator have been violated. See Appendix A for a list of these conditions.

If none of the above procedures corrects the difficulty, return the calculator and charger PREPAID and INSURED to the applicable Service Facility listed on the back cover.

For Technical Assistance

For technical questions such as programming, specific calculator applications, etc., you can call 806-747-3841. We regret that this is not a toll-free number, and we cannot accept collect calls. As an alternative, you can write to:

> Consumer Relations Department
> Texas Instruments Incorporated
> P.O. Box 53
> Lubbock, TX 79408

Because of the number of suggestions which come to Texas Instruments from many sources, containing both new and old ideas, Texas Instruments will consider such suggestions only if they are freely given to Texas Instruments. It is the policy of Texas Instruments to refuse to receive any suggestions in confidence. Therefore, if you wish to share your suggestions with Texas Instruments, or if you wish us to review any calculator program key sequence which you have developed, please include the following in your letter:

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Costa Mesa,
California 92626
(714) 540-7190

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Consumer Service
10700 Southwest Beaverton Highway
Park Plaza West, Suite 11
Beaverton, Oregon 97005
(503) 643-6758

ONE-YEAR LIMITED WARRANTY

WARRANTEE

This Texas Instruments electronic calculator warranty extends to the original purchaser of the calculator.

WARRANTY DURATION

This Texas Instruments electronic calculator is warranted to the original purchaser for a period of one (1) year from the original purchase date.

WARRANTY COVERAGE

This Texas Instruments electronic calculator is warranted against defective materials or workmanship. **THIS WARRANTY IS VOID IF: (i) THE CALCULATOR HAS BEEN DAMAGED BY ACCIDENT OR UNREASONABLE USE, NEGLECT, IMPROPER SERVICE OR OTHER CAUSES NOT ARISING OUT OF DEFECTS IN MATERIAL OR WORKMANSHIP, (ii) THE SERIAL NUMBER HAS BEEN ALTERED OR DEFACED.**

WARRANTY PERFORMANCE

During the above one (1) year warranty period your calculator will either be repaired or replaced with a reconditioned model of an equivalent quality (at TI's option) when the calculator is returned, postage prepaid and insured, to a Texas Instruments Service facility listed on the previous page. In the event of replacement with a reconditioned model, the replacement unit will continue the warranty of the original calculator or 90 days, whichever is longer. Other than the postage and insurance requirement, no charge will be made for such repair, adjustment, and/or replacement.

WARRANTY DISCLAIMERS

ANY IMPLIED WARRANTIES ARISING OUT OF THIS SALE, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO THE ABOVE ONE (1) YEAR PERIOD. TEXAS INSTRUMENTS SHALL NOT BE LIABLE FOR LOSS OF USE OF THE CALCULATOR OR OTHER INCIDENTAL OR CONSEQUENTIAL COSTS, EXPENSES, OR DAMAGES INCURRED BY THE PURCHASER.

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