

# Equation Calculator

The Equation Calculator lets you take advantage of the computing power of the Home Computer without entering formal programs. The versatility and convenience of this feature can be applied to everyday arithmetic problems as well as to advanced mathematical operations.

In addition to the capabilities of a high performance calculator, the Equation Calculator has a unique "visible memory" display that shows you the computation in progress. The data stored in memory, the equation being solved, and the keystrokes you enter are displayed in separate sections of the screen. You can easily see what has been done and change values whenever necessary.

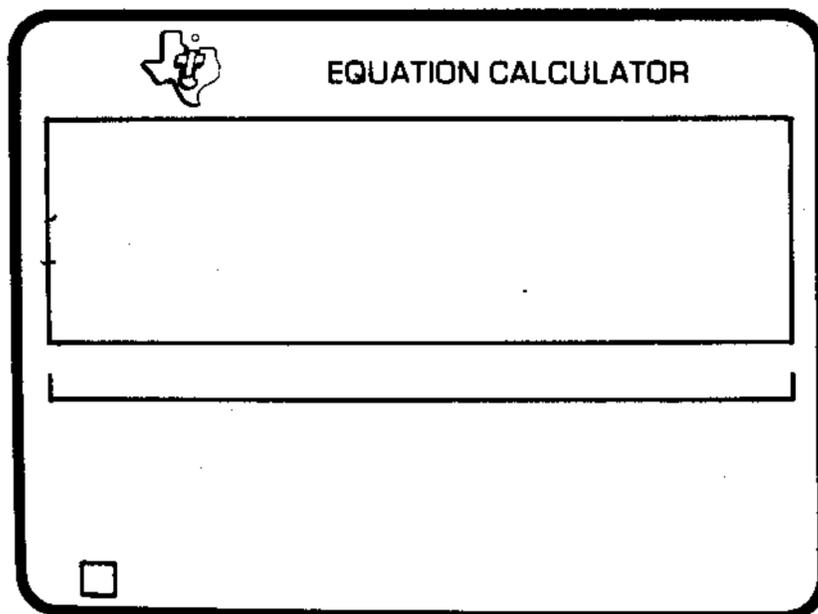
The best way to learn about the capabilities of your Equation Calculator and how to use it is to turn on the computer, select EQUATION CALCULATOR, and work along as you read through this section of the book.

## SELECTING THE EQUATION CALCULATOR

When you turn on your Home Computer, you'll see the master title screen. Press any key, and the master selection list is displayed on your screen. Press the **2** key to select EQUATION CALCULATOR.

## DISPLAY FORMAT

After you press the **2** key the following screen appears:



Notice that the EQUATION CALCULATOR screen is divided into three special-purpose areas. Let's look at these areas, starting at the bottom of the screen. The section on the lower part of the screen is your "work" area. When you "type" in data, it appears first in this section. When you are working on simple numeric calculations, the answers are displayed in this area.

The middle section of the screen is the "equation memory" area. This area will be blank or will display the equation or formula you are currently solving.

The "variable memory" box at the top of the screen displays up to ten variables and the current value you have assigned to each variable. When you are solving a formula or equation to find the value of a variable, the value (or solution) will be labelled and displayed in this area of the screen. When this area is filled (with ten variables and their values), the next variable and its value entered will be displayed in the "work area" at the bottom of the screen. (Variables and their use are discussed in detail in "More Advanced Calculations" on page 23.)

As we go along and actually work through some examples you'll see exactly how each section of the display functions. But before we try some problems, review "A Tour of the Keyboard" on pages 10-12 of this book.

## SPECIAL KEY FUNCTIONS

### ENTER key

The **ENTER** key is used to enter variables and to complete a calculation. For example, to add 2 plus 5:

press **2**  
then press **SHIFT +**  
then press **5**  
then press **ENTER**

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After you press **ENTER**, the results are displayed on the screen.

## **SHIFT =** (Equals Key)

The **SHIFT =** key is used only in assigning a value to a variable. Examples:

INTEREST = 650  
X = Y + 6  
VOL = 25  
A = 3

## **SHIFT** (UP)

The up-arrow key is used to move an equation, formula, or other expression from the bottom line of the "work" area of the screen into the "equation memory" area of the screen. If an expression is already showing in the "equation memory" area, pressing **SHIFT**  replaces that expression with whatever expression is on the bottom line of the work area. If the bottom line is blank, pressing **SHIFT**  clears the "equation memory" area. You must press this key *before* you press **ENTER**.

## **SHIFT** (DOWN)

Pressing the down-arrow key brings the expression in the equation memory area to the bottom line of the work area. (It also remains displayed — and stored — in the equation memory area.) You'll want to bring an expression down from the memory area when you are ready to solve (or execute) it. Also you can bring an expression back to the work area to edit — or change — it in some way. (We'll discuss this in more detail later.) You must press this key *before* you press **ENTER**.

## **SHIFT** (RIGHT)

The right-arrow (forwardspace) key moves the cursor (  ) to the right without erasing characters as it passes across them.

## **SHIFT** (LEFT)

The left-arrow (backspace) key is used to move the cursor (  ) to the left without erasing the characters it passes over.

## **SHIFT F** (DEL)

The delete key is used to delete a number, letter, or other character you've typed on the bottom line of the work area (before you press **ENTER**). Using **SHIFT** , backspace to the character you want to delete. Press **SHIFT F**. The character is deleted, and any numbers or letters following the deleted character on the line are automatically moved one space to the left.

## **SHIFT G** (INS)

The insert key is used to insert a letter, number, or other character into the information you have typed on the bottom line of the work area (before you press **ENTER**). Backspace (using **SHIFT** ) to the point where you want to insert a new character. Press **SHIFT G**. Then type in the new character. The new character is inserted and all the other characters on the line are moved one space to the right. Any characters that are shifted off the end of the line are lost.

## **SHIFT T** (ERASE) or **SHIFT C** (CLEAR)

If you want to clear the bottom line of the work area (before you press **ENTER**), press either **SHIFT T** or **SHIFT C**.

## USING THE CALCULATOR

### Simple Calculations

Let's try working a few problems so you can see exactly how the calculator operates. We'll begin with some simple calculations. First let's calculate the problem  $5 + 3 + 4$  and see how it appears on the display.

- First, press **5**
- then press **SHIFT +**
- then press **3**
- then press **SHIFT +**
- then press **4**
- then press **ENTER**

(Note that you press **ENTER**, *not* **SHIFT =**.)

Notice that the "variable memory" box and the "equation memory" line are empty. The lower "work" area looks like this:

```
5 + 3 + 4
  12
□
```

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The answer (12) is printed on the line below your problem entry. When you press **ENTER** the bottom line "scrolls" up one line. After the calculator prints the answer, the bottom line again "scrolls" up one line. The work area displays up to six (6) lines of input at one time. When the seventh line is entered at the bottom, the top line in the work area scrolls off the screen.

You can type in a calculation or expression that contains up to 28 characters (one full line). When you have typed the maximum characters allowed on the line, you'll hear a "beep." If you press **ENTER** at this point, the entries on the line are calculated, and the answer is displayed on the next line. If you have a long calculation — such as adding up all of your checks for the month — you'll want to divide the entries and make a series of calculations. Try entering several addition or subtraction problems and see how the lines scroll up on the screen.

## POSITIVE AND NEGATIVE NUMBERS

You can enter either positive or negative numbers in your calculations. For positive numbers, the plus sign (+) is assumed. You do not have to type it in, and the Equation Calculator does not print it on the screen. For negative numbers, type a minus sign (–) in front of the number. The calculator also prints a minus sign before the number for negative numbers.

## ORDER OF OPERATIONS

Thus far we've only experimented with addition and subtraction problems. At times, however, you'll want to solve problems that have more than one operation involved. Consider this problem:

$$4 + 10 - 6/2 * 3$$

You can get several different answers to this problem according to the order in which the operations are done. For example,

$$\begin{array}{l} 4 + 10 - 6/2 * 3 \\ = 14 - 6/2 * 3 \\ = 8/2 * 3 \\ = 4 * 3 \\ = 12 \end{array} \quad \text{or} \quad \begin{array}{l} 4 + 10 - 6/2 * 3 \\ = 4 + 10 - 3 * 3 \\ = 4 + 10 - 9 \\ = 14 - 9 \\ = 5 \end{array}$$

Which is correct? Type  $4 + 10 - 6/2 * 3$ , press **ENTER**, and see what answer the Equation Calculator gives you. Is the answer "5"? This is the correct answer. Mathematics has a requirement that there be only one correct solution for any computation. To assure this, there is a commonly accepted order in which arithmetic operations are performed. Your computer performs calculations in this order. In any problems involving mixed calculations — addition, subtraction, multiplication, and division — the arithmetic operations are completed in the following order:

1. Multiplication and division are performed first.
2. Then addition and subtraction are performed.

With the Equation Calculator you can enter a problem directly, from left to right, and the computer automatically sorts the numbers and operations and computes them according to the above rules.

At times you may want to specify the exact order in which an expression is evaluated. In these cases, you use the parentheses ( ) keys to group numbers and operations so that the problem is solved in the order you indicate. The computer completes the computations inside the parentheses first. So the new order of operations becomes:

1. Operations inside the parentheses
2. Multiplication and division operations
3. Addition and subtraction operations

Let's look at how the position of the parentheses alters the answer you get in a problem. Try the following problem:

$$58 + 10/2 * 32$$

If we enter the problem just like this, we get an answer of 218 because:

$$\begin{array}{l} 58 + 10/2 * 32 \\ = 58 + 5 * 32 \\ = 58 + 160 \\ = 218 \end{array}$$

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By adding parentheses in different places, we get a variety of answers. Try  $(58 + 10) / 2 * 32$ :

$$\begin{aligned}(58 + 10) / 2 * 32 \\ &= 68 / 2 * 32 \\ &= 34 * 32 \\ &= 1088\end{aligned}$$

Or try  $(58 + 10 / 2) * 32$ :

$$\begin{aligned}&= (58 + 5) * 32 \\ &= 63 * 32 \\ &= 2016\end{aligned}$$

Experiment with some problems of your own. Notice the difference the parentheses make in computing your problems. (Note: Sometimes you'll see parentheses used to *imply* multiplication, such as  $(2 + 1)(3 + 2) = 15$ . *Your computer will not perform implied multiplications.* You must type the multiplication symbol (\*) between the parentheses.)

## More Advanced Calculations

The Equation Calculator is useful for simple arithmetic calculations. But it can do so much more! In this section we'll look at some of the other ways you can use your calculator.

At times you may want to make several similar calculations in which you change only one or two of the numbers. So, instead of typing in the entire problem each time, you can give a special English-like name to the number you want to change. Then you only have to assign a value (or number) to the special name. This name is called a "variable." In other words, its value can "vary" from problem to problem.

Let's consider an example. You are shopping for furniture. You have located a sofa and a table that you like, but are trying to decide between two different chairs. So you decide to compare the total cost in both cases. The costs are:

sofa: \$575  
table: \$125  
chair: \$305  
chair: \$267

So,  $TOTAL = 575 + 125 + CHAIR$

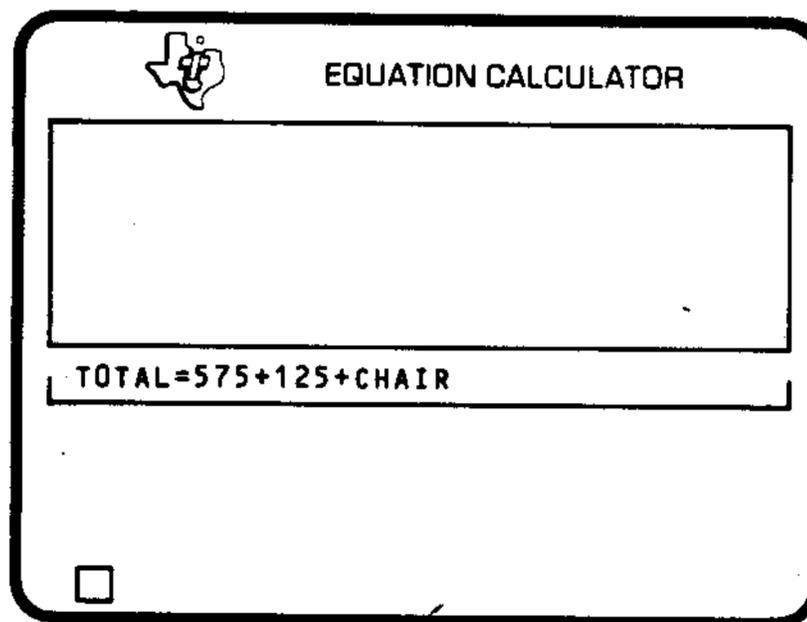
"CHAIR" and "TOTAL" are the names we've given to the *variables* in this problem. The entire expression is called an *equation*. Let's see how the Equation Calculator handles this problem.

First, type the word **NEW** and press **ENTER**. This clears the screen and the memory areas. Then type in the equation:

$$TOTAL = 575 + 125 + CHAIR$$

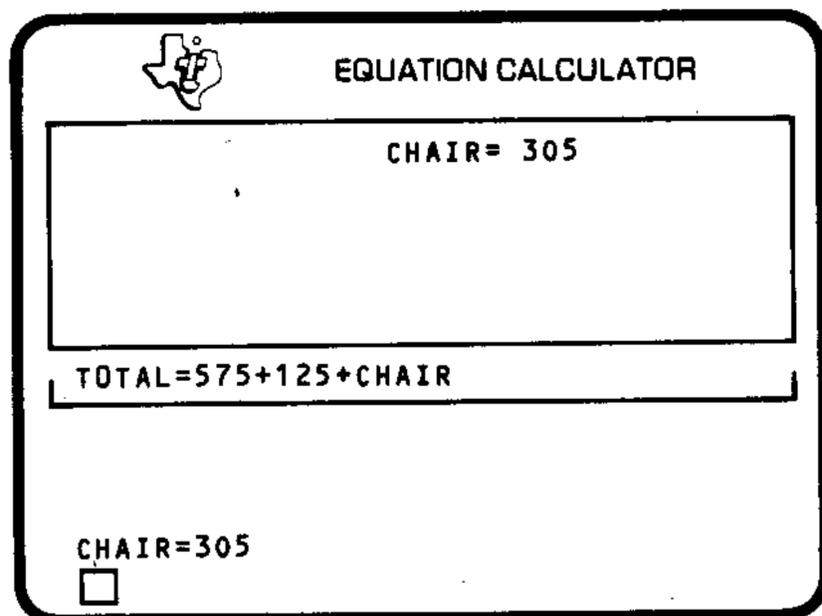
(DO NOT PRESS **ENTER** WHEN YOU FINISH TYPING AN EQUATION.)

The equation appears on the bottom line of the work area. Let's store the equation in the "equation memory" area since we'll use it more than once. To move it to the memory area, press **SHIFT** . Immediately, the equation moves from the bottom line of the work area to the "equation memory" line. This is how your screen looks:

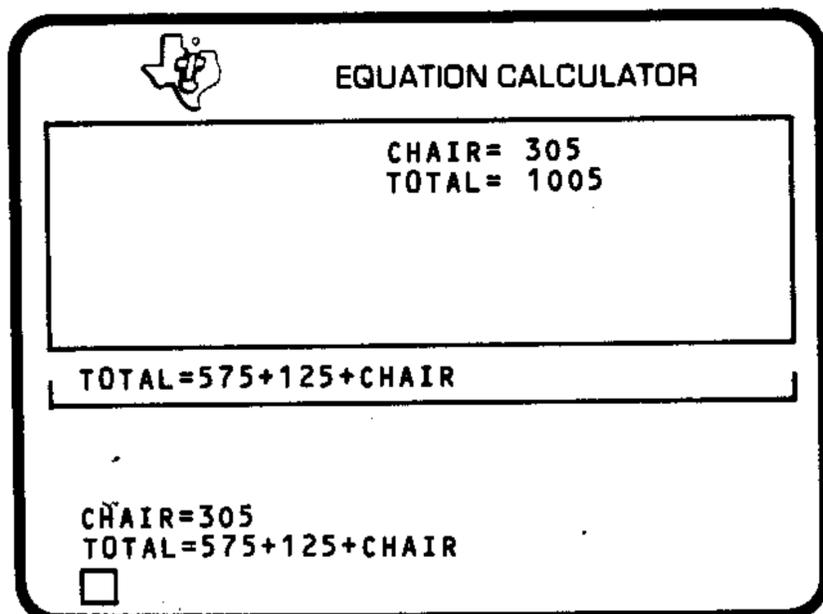


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Now let's assign the first value to CHAIR. Type CHAIR=305. You'll see CHAIR=305 on the bottom line of the work area. Press **ENTER**. When you press **ENTER**, CHAIR=305 moves up one line in the work area, and it is also stored in the "variable memory" box. Your screen now shows:



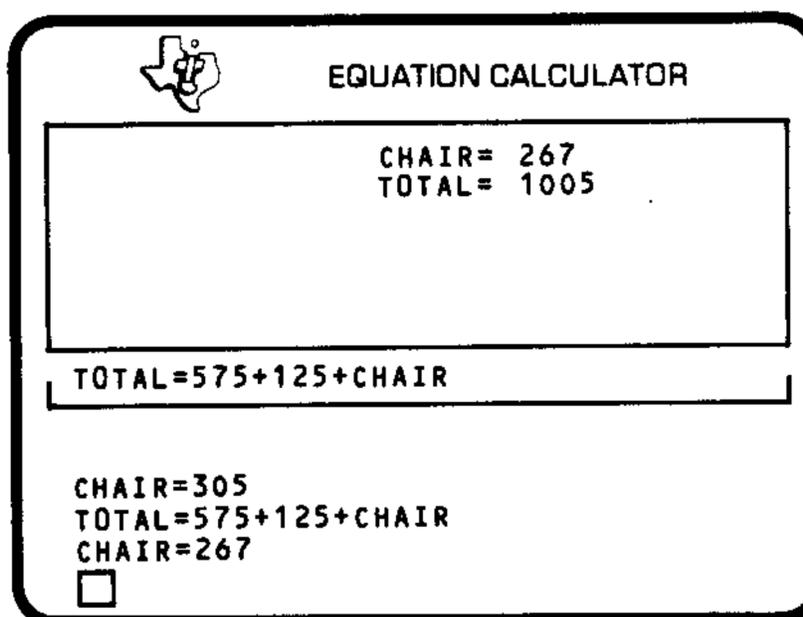
To calculate TOTAL when CHAIR=305, press **SHIFT**  (to bring the equation back to the work area), and press **ENTER**. You now see the answer, TOTAL=1005, in the "variable memory" box:



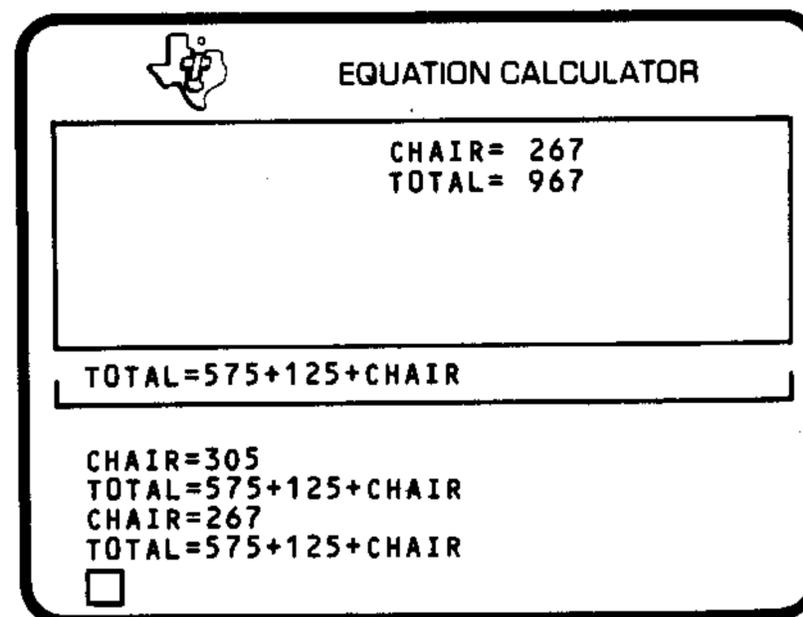
To find TOTAL when CHAIR=267, first type CHAIR=267

Then, press **ENTER**.

The value shown for CHAIR in the "variable memory" box changes to 267 as shown:



Next, bring the equation to the work area again by pressing **SHIFT** , and press **ENTER** to tell the Equation Calculator to evaluate it. When you press **ENTER**, the computer shows the new value for TOTAL (967) in the "variable memory" box at the top of the screen:



You can use almost any letter, group of letters, or word for a variable name. Several abbreviations and words *cannot* be used as variable names because they are reserved for special functions in TI BASIC. (You can use them as a part of a variable name, however.)

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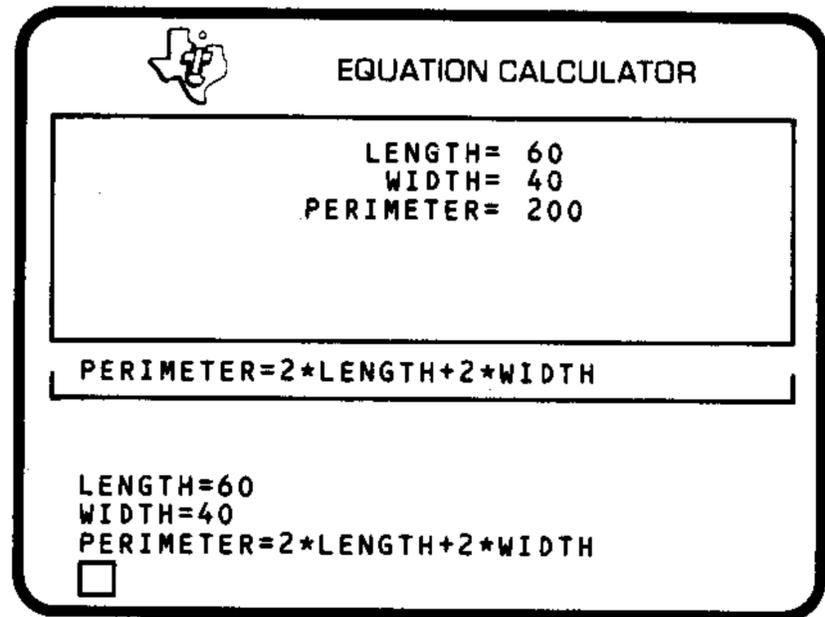
You'll find a list of these words on page 44 of the "BASIC Reference" section of this book. The variable name can be up to fifteen characters in length. You cannot leave spaces between characters in the name, and the only characters allowed are letters, numbers, the "at" sign (@), and the line key (—). If you try to enter a variable name that's too long, has spaces between the characters, or is a reserved word, etc., you'll hear a tone and see an error message such as "BAD NAME" or "INCORRECT STATEMENT." (See page 168 for a complete list of error messages.) If you do get an error message, just type in the name again, correctly.

Let's try another example. You want to fence in a part of your yard and want to find the distance around this rectangular area (or the "perimeter"). You may remember the formula  $PERIMETER = 2 * LENGTH + 2 * WIDTH$ .

First, type **NEW** and press **ENTER** to clear all other entries. Then type in the formula. Let the **LENGTH=60** and the **WIDTH=40**. Here's what you do:

Procedure	Comments
1. Type <b>PERIMETER=2*LENGTH+2*WIDTH</b>	This is the formula used to find <b>PERIMETER</b>
2. Press <b>SHIFT</b> [1]	To store the formula in the "equation memory" area
3. Type <b>LENGTH=60</b>	To give the variable ( <b>LENGTH</b> ) a value
4. Press <b>ENTER</b>	To enter <b>LENGTH=60</b>
5. Type <b>WIDTH=40</b>	To give the variable ( <b>WIDTH</b> ) a value
6. Press <b>ENTER</b>	To enter <b>WIDTH=40</b>
7. Press <b>SHIFT</b> [↓]	To bring the formula (or equation) back to the work area
8. Press <b>ENTER</b>	To tell the Equation Calculator to find the answer

The answer, **PERIMETER=200**, is displayed in the variable memory box at the top of the screen. The entire screen looks like this:

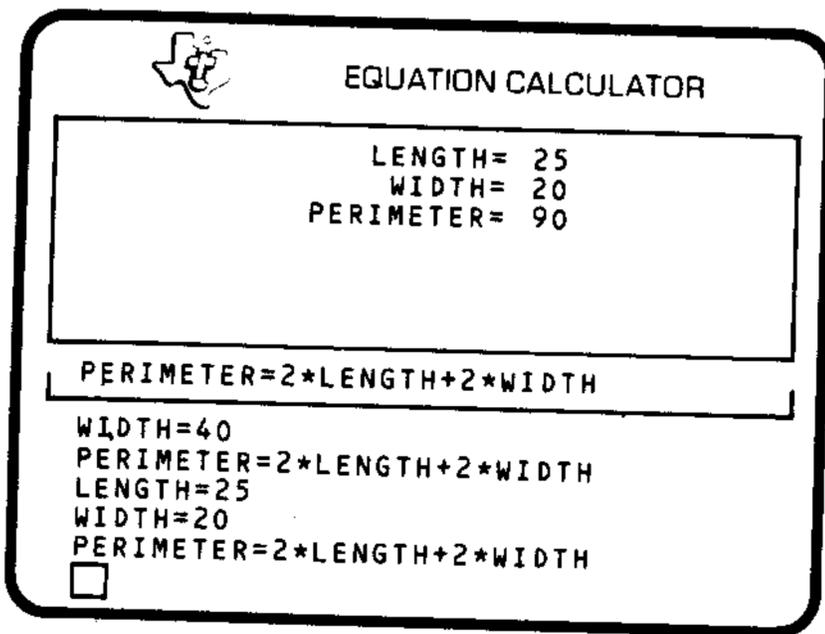


If you want to change the value assigned to one or both of the variables **LENGTH** and **WIDTH**, simply type in the new values and press **ENTER**. Then press **SHIFT** [↓], and press **ENTER** to get the new value for the variable **PERIMETER**. Let's look at this procedure once again, letting **LENGTH=25** and **WIDTH=20**.

Procedure	Comments
1. Type <b>LENGTH=25</b> and press <b>ENTER</b>	"25" replaces "60" in the variable memory box
2. Type <b>WIDTH=20</b> and press <b>ENTER</b>	"20" replaces "40" in the variable memory box
3. Press <b>SHIFT</b> [↓]	To bring formula to work area
4. Press <b>ENTER</b>	To tell the calculator to compute <b>PERIMETER</b> using the new values

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This is how the screen looks now:



(Notice that the original first line (LENGTH=60) scrolls off the top of the work area when you enter the seventh line.)

If you have a long equation, you may need to use an abbreviation or just a single letter as the variable name so that it will fit on one line. We could have written the equation above (PERIMETER=2\*LENGTH+2\*WIDTH) as  $P=2*L+2*W$ .

You can recall the value of any variable, whether or not it is still displayed on the screen, by typing the variable name and pressing **ENTER**.

Anytime you ask the calculator to evaluate a variable that is still undefined (by pressing **ENTER**), the computer will display the value as zero (0). For example, if you type  $X=A+B$  and press **ENTER**, the calculator will display the value  $X=0$  in the variable memory box because you have not assigned a value to the variables, A and B. For the same reason, if you type in the variable INTEREST (without assigning it a value) and press **ENTER**, the calculator displays INTEREST=0 in the work area at the bottom of the screen.

Try entering the following problems, and see how the computer displays your entries and the final answer.

1. Find the Miles Per Gallon (MPG). You have driven 350 miles and put 12.5 gallons of gas in your car. The equation for this problem is:
 
$$\text{MPG} = \text{MILES} / \text{GALLONS}$$

(Ans: 28)

2. (a) Find the annual rate of interest on a \$250 Treasury Bill that is sold for \$244.33 and matures in 90 days. The equation for this problem is:

$$R = (I / (P * T)) * 100 \text{ (to get the answer in \%)}$$

where

R = annual rate of interest

I = interest earned in dollars  
(\$250.00 - \$244.33)

P = principal (\$244.33)

T = time in years (90/365)

(HINT: The answer should be 9.4114517% or 9.41%.)

- (b) Solve the same problem as 2(a), but change the maturity time to 60 days.

(Ans: 14.12%)

Now that you have solved some equations with your Equation Calculator, let's explore some of the additional capabilities of this Home Computer feature.

## Built-In Functions

The Equation Calculator can take advantage of many of the special functions of TI BASIC.

These special functions include such areas as:

- expressing very large or very small numbers in scientific notation
- exponents and roots
- absolute values
- trigonometric functions
- logarithms and antilogarithms
- string functions
- and others

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For complete information about all of the functions, see the "BASIC Reference" section of this book or pages 127-141 of *Beginner's BASIC*. You do not have to follow all of the programming conventions, however, when you are working with the Equation Calculator. You do not have to type "PRINT" or "LET." Let's look at exactly how you enter some of these operations in the calculator.

## Scientific Notation

To enter 98765432100 in scientific notation, type:

9.87654E+10

To enter 0.000000000000123 in scientific notation, type:

1.23E-13

## Exponents

Quite often in mathematical calculations, we must raise some number to a power. The caret or *exponentiation symbol* ( $\wedge$ ) tells the computer that the number following it is a power.

To enter  $8^3$ , type

8 ^ 3

To enter  $25^2$ , type

25 ^ 2

To enter  $y=x^3$ , type

Y = X ^ 3

## Roots

Since many calculations call for finding the *square root* of a number, this function is built into the computer. The letters SQR stand for "square root of" and instruct the computer to find the square root of the number, variable, or expression within the parentheses following the letters.

To enter " $\sqrt{4}$  = the square root of 4", type:

A = SQR(4)

Other roots must be computed by using a form of exponentiation. Computing a root of a number is the same function as raising the number to a power which is the *reciprocal* of the root. Therefore,  $\sqrt[3]{125}$  is the same as  $125^{(1/3)}$

To enter  $\sqrt[3]{125}$ , type:

125 ^ (1/3)

Note that we must use parentheses around the exponent (1/3).

## Trigonometric Functions

The following trigonometric functions are available in your calculator:

SIN( )—Finds the *sine* of the number or numeric expression enclosed in parentheses.

COS( )—Finds the *cosine* of the number or numeric expression enclosed in parentheses.

TAN( )—Finds the *tangent* of the number or numeric expression enclosed in parentheses.

ATN( )—Finds the *arctangent* of the number or numeric expression enclosed in parentheses.

All trigonometric functions are performed by the calculator in radians, rather than degrees. Therefore, if your data is measured in degrees, you'll need to convert the measurement to radians before using it with the function. To convert an angle from degrees to radians, multiply by  $\pi/180$ . To convert from radians to degrees, multiply by  $180/\pi$ .

To enter the *sine* of X, where X is the angle expressed in radians, type:

SIN(X)

Other trigonometric functions are entered in the same manner, using the correct abbreviation.

When using any of these special TI BASIC functions with the calculator, you follow the same procedures as you do with simple calculations or equations. In other words, you continue to press **ENTER**, or **SHIFT**  $\boxed{\text{I}}$ , or **SHIFT**  $\boxed{\text{L}}$  as described previously.

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## Calculation Overflow or Underflow

The Equation Calculator feature of your computer has the same numeric range as TI BASIC. When an overflow occurs, a warning is given with the message "NUMBER TOO BIG." When an underflow occurs, the computer replaces the value of the number with a zero. No warning or error message is given. (See page 37 of the "BASIC Reference" section of this book for a complete discussion of the numeric range of the computer.)

## Editing

Editing the information you have typed into the calculator or changing (or correcting) the equation in the "equation memory" area is very easy. If you want to make a change in the line you have just typed (before you press **ENTER**) simply backspace, using **SHIFT** , to the point of change. Then

Press **SHIFT F** to delete a character

Press **SHIFT G** to insert a character

Then forwardspace, using **SHIFT** , to return to the place you were before backspacing.

To correct errors simply type over the incorrect entries. You can erase characters by pressing the **SPACE BAR**.

If you want to change or correct the equation in the "equation memory" area, press **SHIFT**  to bring the equation to the bottom line of the work area. Next, correct or change the equation as explained above. Then press **SHIFT**  to place the corrected expression in the "equation memory" line.

## Print Separators

If you desire, you can tell the calculator where to print the answers that appear in the work area by using commas, semicolons, colons, or the **TAB** function. See "Print Separators" and "Tab Function" on pages 95-96 of the "BASIC Reference" section of this book or pages 57-66 of *Beginner's BASIC* for a complete discussion of possible print formats.

## Special Features

### Key Words

There are several words you type to give the Equation Calculator special instructions. These words are:

- NEW** – You type **NEW** to tell the computer to clear all previous entries. This clears the entire screen and all calculator memories.
- BYE** – You type **BYE** to tell the computer to leave the Equation Calculator and return to the master title screen.
- LET** – You may (but need *not*) type **LET** when assigning a value to a variable (Example, **LET A=35**).
- PRINT** – You may (but need *not*) type **PRINT** to tell the computer to print an expression (Example, **PRINT A\*2**).

(Note: All of these are TI BASIC commands or statements, and you must press **ENTER** after typing them.)

### Error Messages and Tones

The computer gives several messages in case of errors. See the "BASIC Reference" section of this book for a complete listing of these messages and their meanings.

At times you'll hear warning tones when you are working with your calculator. The most important tone you'll hear is the one indicating you have typed the last allowed character on the bottom line of the work area.

The many features of the Equation Calculator make it a powerful tool that you can use for many applications. In addition to its usefulness as a calculator, it can also serve as an introduction to programming. As you've discovered, the calculator uses most of the functions of TI BASIC. The next section of this book and the separate book *Beginner's BASIC* help you move from the powers of the Equation Calculator into true programming in TI BASIC.