TEXAS INSTRUMENTS

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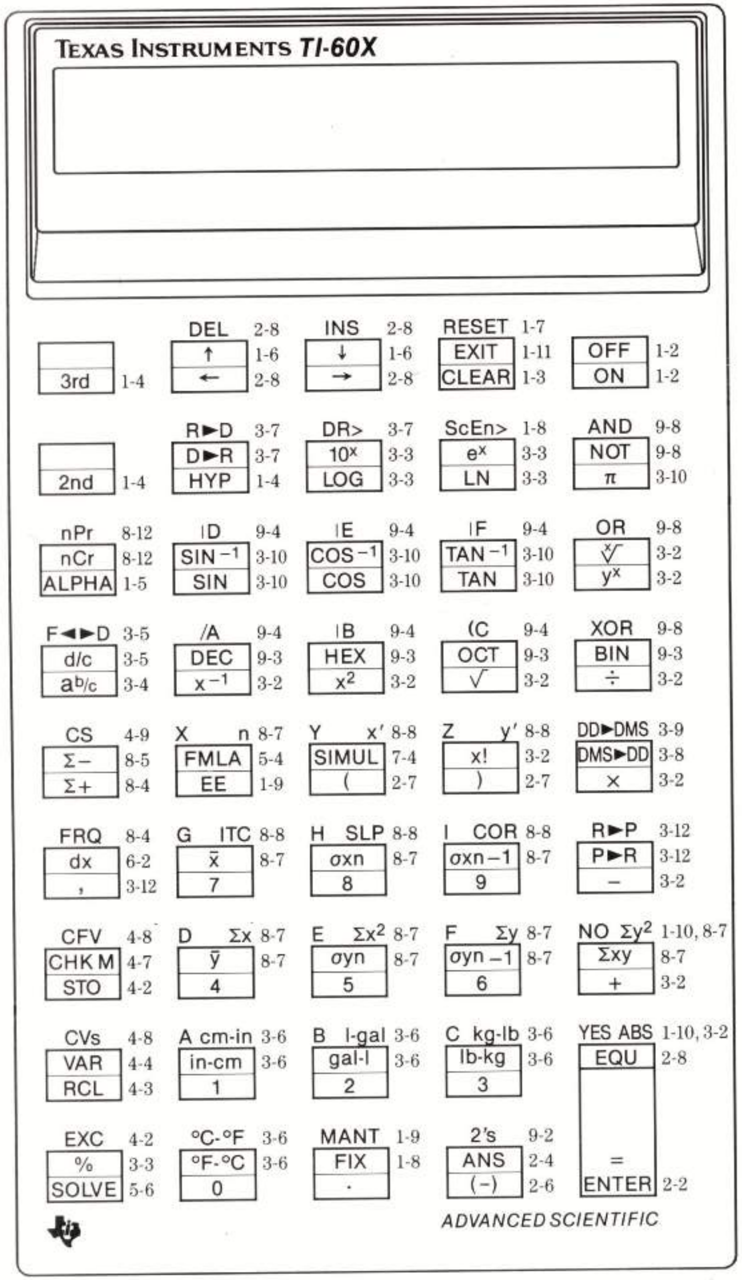
TI-60X

GUIDEBOOK

Key Index

Use this key index when you want to find the page number where a specific key is discussed.



TEXAS INSTRUMENTS

TI-60X

GUIDEBOOK

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Table of Contents

This manual describes how to use the TI-60X calculator. The first chapter gives general instructions on operating the calculator and offers an opportunity to get acquainted with its features. Chapters 2 through 9 describe the calculator features in detail.

Getting Started

Getting Started introduces you quickly to some of the principal features of the TI-60X.

Contents

The First Steps

Before beginning the sample problems in this section, follow the steps on this page to ensure that the TI-60X is reset to its factory settings. Note that resetting the calculator erases all previously entered data.

1. Press [ON] to turn the TI-60X on.
2. To reset the calculator and clear memory, press [3rd] [RESET] (RESET is marked as the third function of the [CLEAR] key).

CLR YN?

3. Press [=/ENTER] to respond "yes" and clear the calculator's memory.

CLEARED

Resetting the calculator:

- Erases all stored variables and formulas.
- Sets the display format to standard decimal notation with floating decimal point.
- Sets the calculator's angle-unit setting to degrees.

You can proceed to the first sample problem without erasing the CLEARED message. If you prefer, you can press [CLEAR] to erase the message.

Entering and Evaluating an Expression

The TI-60X allows you to enter the operations and arguments in an expression just as you would write them. The expression is evaluated when you press [=/ENTER].

Follow these steps to enter and evaluate the expression:

$72^2 - \sqrt{648} + -9.$

1. Enter 72 [x²] [−] [√] 648 [+] [(-)] 9.

72²−√648+-9_

Notice that:

- The expression contains both the minus key [−], which is used for subtraction, and the negate key [(-)], which is used to enter a negative number.
- You press [√] **before** the number 648, the same order in which you would write it on paper.

Review the expression in the display. If you find a mistake, use the [→] and [←] keys to move the cursor to the character you want to correct and then type over it. You may also press [CLEAR] and re-enter the entire expression.

2. Press [=/ENTER] to evaluate the expression.

5149.544156

The TI-60X temporarily stores the last equation you entered. If you have not pressed any other keys, you can recall, modify, and re-evaluate your last equation.

In this example, you use the "Last Equation" feature to retrieve the equation from the previous example. You then change the equation to:

$82^2 - \sqrt{(648 + -9)}$

1. To recall the last equation, press [2nd] [EQU] (EQU is marked as the second function on the [=/ENTER] key).

   $72^2-\sqrt{}648+-9$

   The last equation is displayed, with the cursor blinking under the first character.

2. Type 8 over the 7 and use the [→] key to move the cursor to the 6.

   $82^2-\sqrt{}648+-9$

3. Press [3rd] [INS] (marked as the third function of the [→] key) to turn on the insert function. The **INS** indicator is displayed.

   INS
   $82^2-\sqrt{}648+-9$

4. Press [(] to begin the parenthetical expression.

   INS
   $82^2-\sqrt{}(648+-9$

5. Use [→] to move the cursor to the end of the expression.

   ←
   $2^2-\sqrt{}(648+-9$_

   Notice the ← indicator in the top, left corner of the display. It indicates that the beginning of the expression can be viewed by moving the cursor to the left.

6. Press [)] to close the parenthetical expression.

   ←
   $2-\sqrt{}(648+-9)$_

   Use [→] and [←] to scroll right and left to review the expression.

7. Press [=/ENTER] when you are ready to evaluate the expression. The cursor does not have to be at the end of the expression when you press [=/ENTER].

   6698.721551

Using Variables

You can store values in memory as named variables. A variable name is a single alphabetical character (A–I, X, Y, or Z). These characters are marked above and to the left of some of the keys.

This example stores the result of 1.7 × 3 as variable B and then uses the stored value in two expressions.

1. Press [(] 1.7 [×] 3 [)] [STO] B (B is marked above and to the left of the 2 key).

   Display: `← .7×3) STO B_`

2. Press [=/ENTER] to evaluate the expression and store the result as B. The value of variable B is displayed.

   Display: `5.1`

   You can now use the stored value in one of two ways:

   - Directly, by using [RCL] B.
   - Indirectly, by using [ALPHA] B.

3. To use the stored value directly, press 6.3 [+] [RCL] B. As soon as you press B, the value of variable B is displayed in the expression.

   Display: `6.3+5.1_`

4. Press [=/ENTER] to evaluate the expression and display the result.

   Display: `11.4`

5. Use variable B (current value: 5.1) indirectly in the expression:

   $253 \times B^2 \div B$.

   Press 253 [×] [ALPHA] B [x²] [÷] [ALPHA] B.

   Display: `253×B²÷B_`

   When you use [ALPHA] B instead of [RCL] B, the name of the variable is displayed instead of the value. This indirect reference is especially useful in formula programming.

6. Press [=/ENTER] to evaluate the expression.

   Display: `1290.3`

You can exchange a number with the value stored in a variable.

1. Press 8 [3rd] [EXC] (marked as the third function of the [SOLVE] key), and then press B.

   Display: `8 EXC B_`

2. Press [=/ENTER]. The value 8 is now stored in the variable B, and 5.1 (the old value of B) is shown in the display.

   Display: `5.1`

3. To confirm that the new value of variable B is 8, press [RCL] B.

   Display: `8_`

A formula is an expression that you have named and stored for repeated use. A formula name is a single alphabetical character (A-I, X, Y, or Z) that you assign to an expression during the formula-entry routine. You can recall a formula, change its variables, and solve it whenever you like.

The example on this page uses variable B (value: 8) from the previous example. B will also be used on pages 10 and 11 to illustrate integration.

Follow these steps to enter and evaluate the formula:

A = 438 + √B ÷ C²

1. Press [2nd] [FMLA] (marked as the second function of [EE]). The prompt for the formula name appears.

   `NAME?`

2. Answer the **NAME?** prompt by pressing A. The calculator is ready for you to enter the formula for A.

   `A=_`

3. Enter the formula using these keystrokes:

   438 [+] [√] [ALPHA] B [÷] [ALPHA] C [x²].

   `A=438+√B÷C2_`

4. Press [=/ENTER]. The **SOLVE YN?** prompt lets you either solve the formula or store it without solving.

   `SOLVE YN?`

5. Press [YES] (marked above the [=/ENTER] key). The calculator prompts you to assign or change the formula's variables. Because you defined B in the previous example, its current value is displayed.

   `B=8`

   You could press [CLEAR] to remove any existing value and enter a new value, or you could type over the old value. For this example, you will retain the current value of B.

6. To accept 8 as the value for B, press [=/ENTER]. The next variable name, C, is displayed. C is not currently defined, so you are prompted to enter a value.

   `C=_`

7. To assign a value to C, enter 45 and press [=/ENTER]. The calculator offers you a chance to review the formula's variables.

   `REVIEW YN?`

8. Press [NO] (marked above the [+] key) to solve the formula. Solving the formula causes the result to be stored in a variable with the same name as the formula.

   `→`
   `A=438.001396`

   While reviewing the variables, you can press [SOLVE] at any time to stop the review and solve the formula. If you try to solve a formula before defining all its variables, however, an error condition occurs.

The TI-60X uses Simpson's Rule to integrate a formula. The calculator must be in the decimal number base for integration.

The formula entered in the previous example is used here to demonstrate integration.

A = 438 + √B ÷ C^2

For this integration, use 2 for the lower limit, 5 for the upper limit, and 4 for the number of intervals.

1. Recall formula A by pressing [2nd] [FMLA] A. | Display: A=438+√B÷C²

2. Press [=/ENTER] to accept the formula. | Display: SOLVE YN?

3. Press [YES] to start the prompts for the variables. | Display: B=8

4. Press [=/ENTER] to accept 8 as the value for variable B. | Display: C=45

   You may declare only one independent variable for integration. For this example, C will be the independent variable (the variable you will integrate on).

5. To clear the previously assigned value of C and declare C as the independent variable, press [CLEAR] and then press [2nd] [dx] (marked as the second function of the [,] key). | Display: C= dX _

6. Press [=/ENTER]. You are prompted for the lower limit. | Display: LOW= _

7. Press 2 [=/ENTER] to enter the lower limit. You are prompted for the upper limit. | Display: UP= _

8. Press 5 [=/ENTER] to enter the upper limit. You are prompted for the number of intervals. | Display: INTRV= _

9. Press 4 [=/ENTER] to specify the number of intervals. In accordance with Simpson's Rule, the calculations will use twice the number of intervals you enter. | Display: REVIEW YN?

   The calculator offers you a chance to review the formula's variables, including the independent variable's limits and the intervals.

10. Press [NO] or [SOLVE] to integrate the formula. The message **CALC** is displayed briefly, and then the solution appears. | Display: → A=1314.84873

Solving a System of Simultaneous Equations

The TI-60X has a built-in routine for solving a system of second- or third-order simultaneous equations. The calculator prompts you for the coefficients and assigns each item in the solution set to a variable.

This example solves the following system of simultaneous equations.

$6x + 5y = 1$
$2x + 3y = 4$

The terms of these equations are arranged in row/column order to match the order in which the calculator prompts you for coefficients.

$a_{11}x + a_{12}y = b_1$
$a_{21}x + a_{22}y = b_2$

1. Press [3rd] [RESET] [YES] to clear the calculator. (Solving simultaneous equations requires most of the memory.)

   `CLEARED`

2. Press [2nd] [SIMUL] (marked as the second function of the [(] key) to begin. You are prompted to specify the order of the equations.

   `EQUA 2 OR 3?`

3. Specify the order by pressing 2. You are prompted for the first coefficient, located at row 1, column 1 in the equations.

   `a11=_`

4. Enter a_{11} and the remaining coefficients as prompted.

   6 [=/ENTER] — `a12=_`

   5 [=/ENTER] — `b1=_`

   1 [=/ENTER] — `a21=_`

   2 [=/ENTER] — `a22=_`

   3 [=/ENTER] — `b2=_`

   4 [=/ENTER] — `REVIEW YN?`

5. Press [NO] or [SOLVE] to solve the simultaneous equations. The calculator assigns the two items in the solution set to variables X and Y, and displays X. The ♦ indicator tells you more results are available.

   `♦ X=-2.125`

6. Press [=/ENTER] to view Y.

   `♦ Y=2.75`

   You can continue pressing [=/ENTER] to view X and Y.

7. When finished reviewing the results, press [CLEAR] to exit the simultaneous equations routine.

   `_`

The Getting Started section has introduced you to several basic TI-60X operations. The remainder of this guidebook describes the features already introduced, as well as the other capabilities of the calculator, in more detail.

Fractions You can enter and perform calculations with fractions and convert between fractions and decimals. Entry of fractions is simple because you may enter them in the traditional numerator/denominator format. (Chapter 3)

English/Metric Conversions You can perform eight metric-to-English and English-to-metric conversions. (Chapter 3)

Statistics You can analyze one- and two-variable statistical data. Statistical results include mean, standard deviation, sum of the data, and sum of the squares of the data. You can easily enter trend-line data and perform linear regression. (Chapter 8)

Number Bases The number bases available on the TI-60X include hexadecimal, octal, and binary, as well as decimal. The Boolean logic operators are also available. (Chapter 9)

Chapter 1: Operating the TI-60X

This chapter contains information fundamental to using the functions of the calculator.

Chapter Contents

Turning the TI-60X On and Off

To turn the calculator on, press [ON]. To turn it off, press [2nd] [OFF]. If you forget to turn the calculator off, the APD™ Automatic Power Down feature turns it off for you.

Turning the Calculator On

Press [ON] to turn the TI-60X on.

- If you turned the calculator off manually, the display shows a blank entry line with a flashing cursor. The calculator is ready for a new entry.
- If the APD feature turned the calculator off, the display and cursor will be exactly as you left them, with the exception described below.

Turning the Calculator Off

Before turning the TI-60X off, make sure you have saved any displayed value that you may want to recall later.

To turn the TI-60X off, press [2nd] [OFF]. (OFF is a second function to prevent the calculator from being turned off by mistake.)

- The Constant Memory feature retains stored variables, statistical data, formulas, the current angle-unit setting, the decimal display format, and the current fixed-decimal setting.
- The decimal number base is selected.
- The display is cleared, any error condition is cleared, any variable listing, prompt, or simultaneous equation routine is exited, and the "last answer" and "last equation" are erased.

The APD™ Automatic Power Down Feature

To prolong the life of the batteries, the APD feature turns the TI-60X off automatically after about 15 minutes with no keys pressed.

The effect is the same as manually turning off the calculator, except:

- The currently selected number base is retained.
- The display, the "last answer," and the "last equation" are erased only if a variable listing or simultaneous equation routine was in progress.

Clearing Data

This information summarizes commonly used clearing operations.

Clearing

Press [CLEAR] to clear:

- The entry line, including an expression or displayed result.
- The value of a variable, coefficient, or formula you are entering or reviewing.
- An error condition (indicated by the displayed message **ERROR**).
- An unfinished sequence, such as RCL.

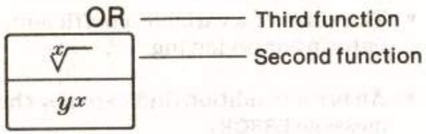
You also can delete variables, formulas, and the statistical data. For instructions, refer to Chapter 4: Memory and Variables.

Using Alternate Functions of Keys

To accomodate the many functions of the TI-60X, most of the keys can perform more than one function. The primary function of each key is marked on the lower half of the key. Alternate functions are marked as described here.

Using Second and Third Functions

The second function of a key is marked on the upper half of the key and is color-coded to the [2nd] key. The third function is marked above the key and is color-coded to the [3rd] key.



To enter a second or a third function, press the [2nd] or [3rd] key and then the key marked with the function you want. If you press [2nd] or [3rd] by mistake, press it again to cancel its effect.

Note: The key markings A through F denote hexadecimal digits. For information on entering hexadecimal digits, refer to page 9–4.

In this guidebook, second and third functions are shown in brackets and are preceded by either the [2nd] or [3rd] symbol; for example, [2nd] [OFF] or [3rd] [RESET].

Using Hyperbolic Functions

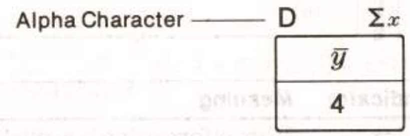
The [HYP] key, located next to [2nd], lets you use the trigonometric keys to perform hyperbolic and inverse hyperbolic functions.

To enter a hyperbolic function, press [HYP] and then the appropriate trig key; for example, press [HYP] [SIN] for hyperbolic sine (sinh).

To enter an inverse hyperbolic function, press [HYP] [2nd] and then the appropriate trig key; for example, press [HYP] [2nd] [SIN^{-1}] for inverse hyperbolic sine ($sinh^{-1}$).

Using Alpha Characters

The uppercase letters A–I, X, Y, and Z are used for variable and formula names and are marked above and to the left of some of the keys. The letters are color-coded to the [ALPHA] key.



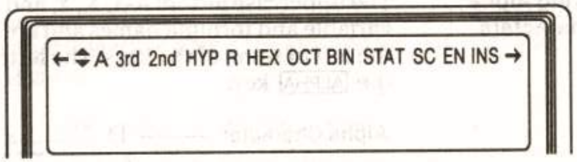
To enter an alpha character, press [ALPHA] and then press the key marked with the letter you want. When you press [ALPHA], the A (alpha) indicator is displayed.

Note: You do not have to press [ALPHA] when using [STO], [RCL], [EXC], or when responding to a displayed prompt for an alpha character. For example, you can press [STO] A instead of [STO] [ALPHA] A. Examples in this guidebook include the [ALPHA] key only when it is required.

The Display and Indicators

The display can show as many as 12 characters of an expression or a result at a time. Indicators show current settings and alternate functions.

The Display Indicators



Indicator	Meaning
←, →	More information is available in the entry line past the left or right edge of the display. Use [←] or [→] to scroll the information into view.
⇕	More items, such as in a list of results, are available above or below the currently displayed item. Press [2nd] [↑] or [2nd] [↓] to scroll the previous or next item into view.
A	The calculator will access the alphabetical character of the next key you press.
2nd, 3rd	The calculator will access the second or third function of the next key you press.
HYP	The calculator will access the **hyperbolic** function of the next key you press.
R	Angles are displayed and interpreted as radians instead of degrees.
HEX, OCT, BIN	The calculator interprets entered numbers and displays results as **hexadecimal**, **octal**, or **binary** numbers.
STAT	The statistics registers contain data.
SC, EN	The calculator displays results in **scientific** or **engineering** notation.
INS	Numbers and functions you enter will be **inserted** into the expression at the cursor position.

Resetting the Calculator

Resetting restores the TI-60X to its factory settings and erases all variables, formulas, and statistics data. Before using reset, you should consider using one of the deleting methods described in Chapter 4: Memory and Variables.

Factory Settings The TI-60X has the following factory settings.

Angle unit setting:	Degrees
Number base setting:	Decimal
Decimal display format:	Standard notation with floating decimal point

Resetting To reset the calculator, press [3rd] [RESET]. The display shows **CLR YN?**

- To restore the factory settings and erase all variables, formulas, and statistics data, press [YES].
- To cancel the reset, press [NO] or [2nd] [EXIT].

Decimal Number Formats

You can select the display format for decimal results. Formats include standard, scientific, and engineering notation, all with floating or fixed (rounded) decimals. You can also enter decimal numbers in any of the formats.

Selecting the Display Format for Results

The decimal display format affects only how numeric results are displayed; you don't have to enter numbers in the display format you selected.

To cycle the display format among standard, scientific, and engineering notations, press [3rd] [ScEn>].

- The **SC** or **EN** indicator shows when you have selected scientific or engineering notation. If neither indicator shows, you have selected standard notation.
- Displayed results are displayed in the new format. However, a result that cannot be displayed in 10 digits or whose absolute value is less than .000000001 is always displayed in scientific notation.

Floating and Fixed Decimal Formats

The floating- or fixed-decimal setting affects how many digits follow the decimal point. This setting affects displayed results in all three notations.

To select either the floating- or fixed-decimal format, press [2nd] [FIX]. The **FIX _** prompt appears.

- To set a fixed number of digits to follow the decimal point, press a number key (0–9).
- To select the floating-decimal setting, press [•]. The floating-decimal setting displays as many as 10 digits plus the sign and the decimal point.

If you were not entering an expression when you pressed [2nd] [FIX], the calculator confirms the new setting by redisplaying the last result.

Converting a Value from One Notation to Another

Because changing the display format converts a displayed result, you can convert a number by first making it a result.

1. Starting with a cleared display, enter the value and press [=/ENTER] to make it a result. The result is displayed in the current display format.
2. Press [3rd] [ScEn>] as necessary to cycle to the desired notation. The value is displayed in the new notation.

Entering Numbers in Scientific or Engineering Notation

You can enter decimal values in scientific or engineering notation regardless of the selected display format.

1. Enter the mantissa. If the mantissa is negative, press [(-)] before entering it.
2. Press [EE] and then enter the exponent. If the exponent is negative, press [(-)] before entering it. The calculator displays an **E** between the mantissa and the exponent.

Example

Enter the value .0001 using scientific notation and temporarily convert the display format to scientific notation.

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	—
Enter the mantissa and exponent.	1 [EE] [(-)] 4 [=/ENTER]	0.0001
Display in scientific notation.	[3rd] [ScEn>]	SC 1E-04
Cycle back to standard notation.	[3rd] [ScEn>]	EN 100 E-06
	[3rd] [ScEn>]	0.0001

Using the Mantissa Function

Although the TI-60X can accept numbers with as many as 10 digits in the mantissa, results that are displayed in scientific notation are shown with the mantissa rounded to a maximum of seven digits.

To display all the digits of the mantissa, press [3rd] [MANT]. The 10-digit display of the result is temporary; the next result you calculate will be shown with a seven-digit mantissa.

Responding to Prompts

Some of the TI-60X functions prompt you for data or instructions. You may, for example, be prompted to make Yes/No choices, enter variable values, or enter data to be used in a calculation.

Data-Entry Prompts

Data-entry prompts display a name, such as a variable or coefficient name, and the current value (or _ if no value has been assigned). A flashing cursor tells you the calculator is waiting for you to enter a new value or accept the current value.

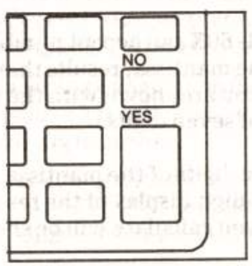
For example, when you solve a formula, the calculator may display a prompt such as **G=_** or **G=55.467**.

- To define G with a value, enter the value and press [=/ENTER]. In most cases, you can enter an expression instead of a value. The calculator uses the result of the expression as the entered value.
- To accept a displayed value of G, press [=/ENTER].
- If you want to change the value of G, use the editing keys ([CLEAR], [←], [→], [3rd] [INS], and [3rd] [DEL]) to change the value, and then press [=/ENTER]. The editing keys are described in detail starting on page 2-8.

Yes/No Prompts

YN? prompts present a choice.

For example, when you press [3rd] [RESET] to reset the calculator, it displays the **CLR YN?** prompt. You respond to such prompts by pressing either the [YES] or the [NO] key.



Note: When answering **YN?** prompts, treat YES and NO as if they are first functions. You don't have to press [2nd], [3rd], or [ALPHA] before pressing [YES] or [NO].

Grouped Results

The results of simultaneous equations are shown as a list of either two or three results. While you are examining a result, the display shows ⇕ to remind you of the other result(s).

- To scroll downward through the list, press [2nd] [↓] or [=/ENTER].
- To scroll upward, press [2nd] [↑].
- To exit, press [2nd] [EXIT].

Exiting from a Prompted Sequence

At times, you may want to exit from a prompted sequence without completing the operation.

- When the first prompt in the sequence is displayed, you can press [CLEAR] to cancel the operation.
- You can always use [2nd] [EXIT] or [2nd] [OFF] to cancel the operation.
- You can exit from some prompts by pressing the keys to start a different prompted sequence. For example, when prompted **NAME?** during the formula routine, you could press [2nd] [VAR] to exit and examine variables.

Chapter 2: Entering and Editing Expressions

The TI-60X lets you enter an expression into the entry line the same as you would write it. You can move through the entry line to review or edit any part of the expression before evaluating it. Most of the information about entering and editing applies both to equations and formulas.

Chapter Contents

Entering and Evaluating an Equation

An expression is a sequence of functions and their arguments that can be evaluated to a single result. On the TI-60X, an equation is an expression you enter for immediate evaluation. Stored expressions, called "formulas," are discussed in Chapter 5: Formula Programming.

Entering an Equation

To create and evaluate an equation, you enter the numbers, variable names, and functions and press [=/ENTER]. When you press [=/ENTER], the calculator evaluates the equation and displays the result.

The maximum allowable length of an equation can range from 71 to 236 characters, depending on the amount of data (such as variables and formulas) you have stored. Each digit you enter occupies one character, and each operation (such as +, √, or LOG) occupies two characters.

To let you know when you are approaching the limit, the cursor shape changes from an underscore (_) to a box (■) when within a few characters of the limit.

Example of an Equation

Evaluate $3.76 \div (-7.9 + \sqrt{5}) + \log 45$.

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	_
Begin expression.	3.76 [÷]	3.76÷
Begin parentheses.	[(]	3.76÷(
Enter negative 7.9.	[(-)] 7.9	3.76÷(-7.9
Add square root of 5.	[+] [√] 5	← 76÷(-7.9+√5
Complete parentheses.	[)]	← 6÷(-7.9+√5)
Add log 45.	[+] [LOG] 45	← √5)+ LOG 45
Evaluate equation.	[=/ENTER]	0.989362739

Notes on Entering Expressions

- To make expressions easy to read, The TI-60X shows a few symbols differently in the display than on the key labels. For example, when you press 16 [x²], the display shows **16²**.
- The calculator can show as many as 12 characters of the entry line. If an expression is longer than 12 characters, as shown by the ← and → indicators, use the [←] and [→] keys to scroll the expression left and right.
- Before entering expressions that include trig functions or polar/rectangular conversions, make sure you select the appropriate angle unit (degrees or radians), as described on page 3–7.

Chaining Equations

You may want to see the intermediate results of specific parts of a long expression. You can accomplish this on the TI-60X by chaining parts of the expression and evaluating each part separately.

Methods of Chaining

You can use either of two methods to continue an equation after calculating an intermediate result. The method you use depends on how you want to use the result in the next equation.

- If the next function you want to use is the type that **follows** its argument (such as 254 x^{-1} or 254 y^x 3), simply press the key for the function and continue the expression. An example is shown below.
- If the next function you want is the type that **precedes** its argument (such as **sin** 254), press the key for the function and then press [2nd] [ANS] to recall the last answer. An example is shown on the next page.

Example

Calculate $40^3 \div 8$, first displaying the intermediate value of 40^3.

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	—
Evaluate 40^3.	40 [y^x] 3 [=/ENTER]	64000
Complete equation.	[÷] 8	64000÷8
Evaluate.	[=/ENTER]	8000

Recalling the Last Answer

The TI-60X temporarily stores the result of the last equation or formula. You can press [2nd] [ANS] to recall this answer and use it anywhere within an equation or formula.

The following events also affect the last answer:

- An error condition. This sets the value of last answer to zero.
- Recalling a variable with [RCL]. This sets last answer to the value of the variable.
- All statistics functions except x′ and y′.

Example

Calculate $\sqrt{12 \times .35}$, first displaying the intermediate value of $12 \times .35$.

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	—
Evaluate $12 \times .35$.	12 [×] .35 [=/ENTER]	4.2
Use last answer.	[√] [2nd] [ANS]	√4.2
Complete.	[=/ENTER]	2.049390153

Because the TI-60X follows rules of algebraic hierarchy, you can enter expressions as you would write them.

Order of Evaluation

The Equation Operating System uses the following priorities when evaluating an expression. High-priority functions are completed before low-priority ones.

Priority	Operations
1 (highest)	(–), x^2, x!, x^{-1}, conversions
2	√, logs, trig functions, hyperbolics, logical NOT, 2's, ABS
3	combinations, permutations
4	y^x, $\sqrt[x]{y}$
5	×, ÷
6	+, −
7	logical AND
8 (lowest)	logical OR, logical XOR

Notes:

- The expression is evaluated when you press [=/ENTER]. The cursor can be in any position in the expression when you press [=/ENTER].
- The negate function, displayed as a narrow minus sign, is for entering negative values. To represent a negative value, you must press [(-)] **before** entering the value. You cannot use [−] (the minus key) for this purpose.
- For priorities 3 through 8, functions within a priority group are evaluated from left to right.
- If an expression contains two or more priority-2 functions in a row, they are evaluated from right to left. If the negate function is adjacent to a priority-2 function, negate follows the same rule. For example, – SIN 25 is treated as – (sin 25).
- Implied multiplication is not recognized. You must specify [×] for all multiplication.

EOS Example

$$-12^2 + \sqrt{225} \times .2 \; y^x \; 3 \div 4$$

① $-12^2 + \sqrt{225} \times .2 \; y^x \; 3 \div 4$

② $144 + 15 \times .2 \; y^x \; 3 \div 4$

③ $144 + 15 \times .008 \div 4$

④ $144 + .12 \div 4$

⑤ $144 + .03$

144.03

① Highest priority (negation and x^2) and next highest (√) are completed first.

② y^x is completed next because it has higher priority than +, ×, and ÷.

③ Although × and ÷ have equal priority, × is completed first in this expression because it appears first.

④ ÷ is completed before the lower-priority +.

⑤ Remaining operation (+) is completed.

Using Parentheses

You can use parentheses to group parts of an expression that you want evaluated separately from the rest of the expression. For example, in the expression (1+5) ÷ 3, the calculator evaluates (1+5) before performing the division. The result is 6 ÷ 3.

Note: Parentheses are required for entering rectangular and polar coordinates (see Chapter 3).

Editing the Entry Line

You can move the cursor along the entry line to any point in an expression, where you can then type over items, delete items, and insert new ones. The editing features operate when you are entering expressions and when you are reviewing variable values and coefficients.

Recalling the Last Equation

You may want to edit the last equation evaluated, either to modify it or to correct an error.

To display the last equation, press [2nd] [EQU]. The equation is shown with the flashing cursor on the first character.

If an error occurs when you attempt to evaluate an equation or formula, press [2nd] [EQU] instead of [CLEAR] to display the equation with the cursor positioned near the probable cause of the error. You can use the editing features to correct the error.

Note: The last equation is only available immediately after evaluating an equation or formula. It is erased when you begin a new expression or perform another operation, such as storing a variable or recalling the "last answer."

The Cursor Keys

The [←] and [→] keys move the cursor left and right along the entry line, scrolling the line through the display if necessary. The cursor stops when it reaches the beginning or end of the expression.

When you press and hold a cursor key, the cursor movement repeats.

The Edit Keys

Besides typing over items in the entry line, you can modify it using the following keys.

Key	Action
[3rd] [DEL]	Deletes the character or symbol at the cursor position.
[3rd] [INS]	Turns the insert mode and the **INS** indicator on or off. In the insert mode, you can insert numbers, variable names, or functions in the expression.
[CLEAR]	Clears the expression or value.

Deleting Characters or Symbols

1. Use [←] or [→] to position the cursor on the character or function you want to delete.

2. Press [3rd] [DEL].

   The character or function is deleted. All the characters of a function represented as a group of characters (such as **LOG** or **SIN**) are deleted together.

The example on the next page demonstrates deleting.

Inserting Characters or Symbols

1. Use [←] or [→] to position the cursor on the character in front of which you want to insert.

2. Press [3rd] [INS].

   The **INS** indicator shows in the display.

3. Enter the items you want to insert.

4. End the insert in one of the following ways:

   - Press [3rd] [INS] again.
   - Press [←] or [→].

Note: You don't have to use insert with [2nd] [ANS] or [RCL]. The last answer or recalled variable value is always inserted ahead of the cursor position.

The example on the next page demonstrates inserting.

(continued)

Editing Example

Evaluate the equation:

$$345 \times \sqrt{3^8 + \log 25}$$

Then recall the equation and edit it to calculate:

$$32 \times \sqrt{30^8 + \ln 25}$$

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	—
Enter the equation.	345 [×] [√] [(] 3 [y^x] 8 [+] [LOG] 25 [)]	← ^{x}8+ LOG 25)_
Evaluate.	[=/ENTER]	27947.97694
Recall the equation.	[2nd] [EQU]	→ 345×√(3y^{x}8+
Change **345** to **32**.	[→] 2 [3rd] [DEL]	→ 32×√(3y^{x}8+L
Change **3 y^x 8** to **30 y^x 8**.	[→] [→] [→] [→] [3rd] [INS] 0	INS → 32×√(30y^{x}8+
Change **LOG** to **LN**.	[→] [→] [→] [LN]	← → (30y^{x}8+ LN 2
Evaluate new equation.	[=/ENTER]	25920000

Chapter 3: Math Operations

The TI-60X can perform a wide range of math operations. The operations are grouped by category in this chapter.

Chapter Contents

General Math Functions

These tables list the most commonly used math operations and functions.

Arithmetic, Power, and Root Functions

Operations	Example	Keystrokes	Display
+, −, ×, ÷	75 − 12 × 2	75 [−] 12 [×] 2	75−12×2
		[=/ENTER]	51
− (negation)	23 × −4	23 [×] [(−)] 4	23× -4
		[=/ENTER]	-92
x^2	6^2	6 [x^2]	6^2
		[=/ENTER]	36
√	$\sqrt{16}$	[√] 16	√16
		[=/ENTER]	4
x^{-1}	1/4	4 [x^{-1}]	4^{-1}
		[=/ENTER]	0.25
y^x	2^5	2 [y^x] 5	2y×5
		[=/ENTER]	32
$\sqrt[x]{\ }$	$\sqrt[5]{32}$	5 [2nd] [$\sqrt[x]{\ }$] 32	5×√32
		[=/ENTER]	2

Notes

- The negate key, [(−)], is for entering negative values. You must press [(−)] **before** entering the value. You cannot use the [−] minus key for this purpose.
- x^{-1} is the equivalent of the reciprocal (1/x).

Number Functions

Operations	Example	Keystrokes	Display
x!	5!	5 [2nd] [x!]	5!
		[=/ENTER]	120
ABS(x)	ABS(−3)	[3rd] [ABS] [(−)] 3	ABS -3
		[=/ENTER]	3

Note

The range of x values for factorial (x!) calculations is 0–69 (integers only).

Logarithms and Percentages

You can calculate common and natural logs and perform several percentage functions.

Logarithms

Operation	Example	Keystrokes	Display
log	log 1	[LOG] 1	LOG 1
		[=/ENTER]	0
10^x	10^0	[2nd] [10^x] 0	10^0
		[=/ENTER]	1
ln	ln 2	[LN] 2	LN 2
		[=/ENTER]	0.693147181
e^x	$e^{0.69}$	[2nd] [e^x] .69	e^.69
		[=/ENTER]	1.993715533

Percentage

Operation	Example	Keystrokes	Display
%	150% of 2	2 [×] 150 [2nd] [%]	2×150%
		[=/ENTER]	3
% add-on	145 + 15%	145 [+] 15 [2nd] [%]	145+15%
		[=/ENTER]	166.75
% discount	69.95 − 20%	69.95 [−] 20 [2nd] [%]	69.95−20%
		[=/ENTER]	55.96
% ratio	3 = 150% of what?	3 [÷] 150 [2nd] [%]	3÷150%
		[=/ENTER]	2

Fractions

The TI-60X lets you enter fractions and mixed numbers. You can perform calculations on fractions and on combinations of fractions, mixed numbers, and decimal numbers. If you store a fraction as a variable and later recall it in the decimal number base, it is displayed as a fraction.

Entering Pure Fractions

To enter a pure fraction (such as 1/6) or an improper fraction (such as 6/4) as **a/b**:

1. Enter the digits for **a** and press [ab/c].

   The display shows "/" to separate **a** from **b**.

2. Enter the digits for **b**.

You can use as many as six digits for **a** and as many as three digits for **b**.

Entering Mixed Fractions

To enter a mixed fraction (such as 3 1/6) as **a b/c**:

1. Enter the digits for **a** and press [ab/c].

   The display shows "/" to separate **a** from **b**

2. Enter the digits for **b** and press [ab/c].

   The display shows "/" to separate **b** from **c**.

3. Enter the digits for **c**.

You can use as many as three digits each for **a**, **b**, or **c**.

Example

Evaluate 5 7/8 + 3 1/3.

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	—
Enter 5 7/8.	5 [ab/c] 7 [ab/c] 8	5/7/8
Add 3 1/3.	[+] 3 [ab/c] 1 [ab/c] 3 [=/ENTER]	9 5/24

Display Limitations for Fractional Results

Not all decimal fractions can be displayed in fractional form. The result of (99¾)², for example, contains more than three digits in its integer portion (9950). Such results are displayed in decimal form.

Displaying Mixed-Number Results

When the result of a calculation is a mixed-number fraction, the number is displayed in its proper form, such as 6 7/8.

To temporarily display the result as an improper fraction, such as 55/8, press [2nd] [d/c]. The number is restored to its proper form when you press [2nd] [d/c] or any operation key.

If you press [2nd] [d/c] while entering an equation, the calculator immediately evaluates the equation. If the result is a mixed number, it is displayed as an improper fraction.

Note: You cannot include [2nd] [d/c] in a formula.

Converting Between Fractions and Decimals

If the last operation evaluated in an expression involves a fractional argument and the result has a non-integer portion, the result is displayed as a fraction. This is subject to the display limitations described on the previous page.

To convert a result between its fractional and decimal forms, press [3rd] [F◄►D] [=/ENTER] while the result is in the display.

Example

Evaluate 3 1/6 − 7/8. Display the result as an improper fraction and then convert it to a decimal number.

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	—
Calculate 3 1/6 − 7/8.	3 [ab/c] 1 [ab/c] 6 [−] 7 [ab/c] 8 [=/ENTER]	2 7/24
Display result as improper fraction.	[2nd] [d/c]	55/24
Convert to decimal.	[3rd] [F◄►D] [=/ENTER]	2.291666667

Note: As soon as you press [3rd] [F◄►D], the entered fraction 55/24 is displayed as a mixed number.

Metric Conversions

This table lists the built-in English/metric conversions. The conversion keys are grouped toward the bottom of the keyboard.

Conversion	Key Sequence	Formula Used
n inches to centimeters	n 2nd [in-cm]	$n \times 2.54$
n centimeters to inches	n 3rd [cm-in]	$n \times .3937007874$
n U.S. gallons to liters	n 2nd [gal-l]	$n \times 3.785411784$
n liters to U.S. gallons	n 3rd [l-gal]	$n \times .2641720524$
n pounds to kilograms	n 2nd [lb-kg]	$n \times .45359237$
n kilograms to pounds	n 3rd [kg-lb]	$n \times 2.204622622$
n °Fahrenheit to °Celsius	n 2nd [°F-°C]	$(n-32) \times (5/9)$
n °Celsius to °Fahrenheit	n 3rd [°C-°F]	$(1.8 \times n) + 32$

Examples

Convert the following:

- .03 inches to centimeters.
- 24 grams to pounds.

Procedure	Keystrokes	Display
Clear entry line.	CLEAR	—
Convert .03 inches.	.03 2nd [in-cm]	.03 IN►CM
	=/ENTER	0.0762
Convert 24 grams (.024 kg).	.024 3rd [kg-lb]	.024 KG►LB
	=/ENTER	0.052910943

Angle Settings and Angle Conversions

Before you begin calculations that involve angles, such as trig functions and polar/rectangular conversions, be sure to set the calculator for the correct angle unit. You can select degrees or radians.

Selecting the Angle Unit

When you evaluate an expression, the calculator interprets angles in the expression according to the currently selected angle-unit setting. Angle results are displayed in the current angle unit unless you convert them.

To alternate the angle-unit setting between degrees and radians, press 3rd [DR>].

When the selected angle unit is radians, an **R** indicator shows in the display. No indicator is displayed when you select degrees (the default unit).

Note: Pressing 3rd [DR>] does not convert a displayed angle, but the new setting affects all subsequent calculations involving angles.

Converting Between Degrees and Radians

To convert a result, press either 2nd [D►R] (convert degrees to radians) or 3rd [R►D] (convert radians to degrees), and then press =/ENTER.

These two functions temporarily override the current angle-unit setting.

Angle-Unit Example

Find the arcsine, in radians, of .58. Then convert the resulting angle to degrees.

Procedure	Keystrokes	Display
Clear entry line.	CLEAR	—
Select radians.	3rd [DR>]	— R
Enter expression.	2nd [SIN-1] .58	R SIN-1 .58
Evaluate.	=/ENTER	R 0.618728691
Convert to degrees.	3rd [R►D] =/ENTER	R 35.45054264
Reselect degrees.	3rd [DR>]	35.45054264

Decimal Degrees and Degrees/Minutes/Seconds

You can enter a degree angle in degrees, minutes, and seconds (DMS format), provided you convert the entry to decimal for calculations. You can convert degree angles between decimal and DMS. This feature also can be used with hours, minutes, and seconds.

Entering Angles in DMS Format

To represent an angle in degrees, minutes, and seconds, enter the angle as described below and press [2nd] [DMS►DD].

D . MM SS s

- Integer degrees (°) — D
- Minutes (′) — MM
- Seconds (″) — SS
- Fractional part of a second — s

- Integer degrees (D) and fractional parts of a second (s) can have multiple digits, provided the entire DMS number does not exceed 10 digits.
- Minutes (MM) and seconds (SS) are two-digit values. Include leading or trailing zeros where needed to place the digits in the proper positions. For example, enter the angle 9°7′50.55″ as 9.075055.

Unless a DMS number is followed immediately by [2nd] [DMS►DD], the calculator interprets it as a decimal. When you include [2nd] [DMS►DD], the calculator interprets the number as a DMS angle and converts it to its decimal equivalent for calculation.

Example

Evaluate 5°50′45″ + 8°35′30″.

Note: Select the decimal number base before entering this example.

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	—
Enter first angle.	5.5045 [2nd] [DMS►DD] [+]	← .5045 ►DD +
Enter second angle.	8.353 [2nd] [DMS►DD]	← + 8.353 ►DD
Show decimal result.	[=/ENTER]	14.4375

Converting an Angle to DMS Format

To convert a decimal-degree angle to DMS format, enter the angle and press [3rd] [DD►DMS] [=/ENTER].

The converted angle is displayed with temporary symbols for degree, minute, and second (**DDD°MM′SS.s″**). (If you use [3rd] [DD►DMS] in a formula, the temporary symbols are **not** shown in the result.)

When you press a key, the temporary symbols are removed and the decimal point replaces the degree symbol. The number is **not** converted to its decimal equivalent; it represents a DMS angle as you would enter it.

If the integer degree (DDD) portion of a DMS result is greater than 999, an error condition occurs.

Example

Evaluate 6.25° + 6°25′30″ and convert the result to DMS.

Note: Select the decimal number base before entering this example.

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	—
Enter decimal angle.	6.25 [+]	6.25+
Enter DMS angle.	6.253 [2nd] [DMS►DD]	← +6.253 ►DD
Evaluate	[=/ENTER]	12.675
Convert to DMS.	[3rd] [DD►DMS] [=/ENTER]	12°40′30.0″

Trigonometric Functions

You can easily perform calculations involving sine, cosine, tangent, and their inverses. Because all numbers that represent angles are interpreted according to the current angle-unit setting, be sure to set the calculator for the correct angle unit before you begin your calculation.

Operation	Example	Keystrokes	Display
sin, cos, tan	sin 45	[SIN] 45	SIN 45
		[=/ENTER]	0.707106781
$\sin^{-1}$, $\cos^{-1}$,	$\sin^{-1}$ 1	[2nd] [SIN-1] 1	SIN-1 1
$\tan^{-1}$		[=/ENTER]	90
Calculation with π	$\pi\,12^2$	[π] [×] 12 [x2]	$\pi \times 12^2$
		[=/ENTER]	452.3893421

Notes

- The above examples assume the degree angle-unit setting.
- **SIN-1**, **COS-1**, and **TAN-1** are the inverse trig functions arcsine, arccosine, and arctangent, respectively. The TI-60X calculates the smallest angle that satisfies the description.
- The tangent of 90° (or any odd-numbered multiple of 90°, such as 270°) is undefined. Attempting to calculate the tangent of such an angle causes an error.
- Pi is stored as a constant in the TI-60X. The symbol π is displayed and the value 3.14159265359 is used in calculations.

Hyperbolic Functions

You use the trig keys to perform hyperbolic functions. Unlike with trig functions, however, the angle-unit setting does not affect the results of hyperbolic functions.

Using the Hyperbolic Functions

Key Sequence	Function
[HYP] [SIN]	hyperbolic sine (sinh)
[HYP] [2nd] [SIN-1]	inverse hyperbolic sine ($\sinh^{-1}$)
[HYP] [COS]	hyperbolic cosine (cosh)
[HYP] [2nd] [COS-1]	inverse hyperbolic cosine ($\cosh^{-1}$)
[HYP] [TAN]	hyperbolic tangent (tanh)
[HYP] [2nd] [TAN-1]	inverse hyperbolic tangent ($\tanh^{-1}$)

Pressing [HYP] displays the **HYP** indicator. If you press [HYP] and then a key that does not have a hyperbolic function, the key performs its normal function. If you press [HYP] by mistake, press it again to cancel its effect.

Example Calculate sinh 3 and $\tanh^{-1}$ 0.5.

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	—
Enter sinh 3.	[HYP] [SIN] 3	SINH 3
Evaluate.	[=/ENTER]	10.01787493
Enter $\tanh^{-1}$ 0.5.	[HYP] [2nd] [TAN-1] .5	TANH-1 .5
Evaluate.	[=/ENTER]	0.549306144

As with the trig functions, all numbers that represent angles in polar/rectangular conversions are interpreted according to the current angle-unit setting. Be sure to set the calculator for the correct angle unit before you perform polar/rectangular conversions.

Entering Rectangular and Polar Coordinates

Coordinate pairs must be in the decimal number base.

The pairs must be enclosed in parentheses, with the two parts separated by a comma. For example, the coordinate pair (7.8,7.5) is entered with the following keystrokes:

[(] 7.8 [,] 7.5 [)]

Either part of a coordinate pair can be a value or an expression, such as (ln 6,√2) and (7^{-1},$\tan^{-1}$ 3).

Converting Coordinates

To convert from rectangular to polar, enter the coordinate as (x, y) and press [3rd] [R▶P] [=/ENTER]. The resulting polar coordinate is displayed with an angle symbol separating r and θ.

To convert from polar to rectangular, enter the coordinate as (r, θ) and press [2nd] [P▶R] [=/ENTER]. The resulting rectangular coordinate is displayed with a comma separating x and y.

Example

Convert the rectangular coordinates (0,4) to polar and then convert the result back to rectangular.

Note: Select the decimal number base and the degree angle unit before entering this example.

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	—
Enter rectangular coordinates.	[(] 0 [,] 4 [)]	(0,4)
Convert to polar.	[3rd] [R▶P] [=/ENTER]	(4∠90)
Convert back to rectangular.	[2nd] [P▶R] [=/ENTER]	(0,4)

Chapter 4: Memory and Variables

Values can be stored to or recalled from memory by using variables. This chapter describes the relationship between memory, variables, and other stored entries and explains how to perform mathematical operations directly on stored values.

Chapter Contents

A variable is a single alphabetical character that refers to a location in memory where a value is stored. The value can be a real number or a fraction.

Storing a Value to a Variable

A variable is undefined until you store a value to it. After you have stored a value to a variable, you can use that value in an expression by entering the name of the variable. If you use an undefined variable in an operation (except for the formula routine), **ERROR** is displayed.

The [STO] key allows you to store a value to a variable. The ALPHA function is built into the STO function, so you don't have to press [ALPHA] before you press the key for an alphabetical character.

Example Keystrokes	Effect
39 [STO] A [=/ENTER]	Stores 39 in A.
39 [STO] A [STO] B [=/ENTER]	Stores 39 in A and in B.
2 [+] 5 [STO] C [=/ENTER]	Stores 5 in C.
[(] 2 [+] 5 [)] [STO] C [=/ENTER]	Stores 7 in C.
5 [+] [(] 2 [+] 5 [)] [STO] C [=/ENTER]	Stores 7 in C.

Variable Names and Formula Names

Variables and formulas both occupy memory space, as described on page 4-6. They also share the characters A through I, X, Y, and Z as names.

When a formula is evaluated, it creates a variable with the same name as the formula and stores the result of the formula in the variable. If a variable with this name is already defined, its value is replaced by the result of the formula.

Exchanging Values

The [3rd] [EXC] key sequence lets you store a new value to a variable and display its old value in one operation. For example, assume that 25 is currently stored in A and you enter the following keystrokes:

88 [3rd] [EXC] A [=/ENTER]

The new value of 88 is stored in A, and the old value of 25 is displayed. Note that the ALPHA function is built into the EXC function.

Displaying the Value of a Variable

To display the value of a variable, enter one of the following key sequences in the entry line:

- [RCL] A
- [ALPHA] A [=/ENTER]

The ALPHA function is built into the RCL function. When you press the [RCL] key, **RCL** is displayed until you press the key for an alphabetical character. Then **RCL** and the variable name are replaced by the value of the variable.

Using the Value of a Variable in an Expression

To use the value of a variable in an expression, you can either recall the value directly with the [RCL] key, or you can include the variable name in the expression.

- When you use the [RCL] key to recall a variable in an expression, the value of the variable is displayed as soon as you press the key for the variable name.
- When you use the [ALPHA] key to reference a variable in an expression, the variable name remains in the expression. The current value of the variable is used to evaluate the expression when you press [=/ENTER].

Example Keystrokes	Effect
2 [+] [RCL] C [=/ENTER]	Inserts the value of C in the expression, adds it to 2, and displays the result.
2 [+] [ALPHA] C [=/ENTER]	Adds the value of C to 2 and displays the result. (Keeps the variable name in the expression.)

The [2nd] [VAR] key sequence allows you to review and edit the variables you have defined. You can also define a new variable with [2nd] [VAR].

Reviewing Stored Variables

1. Press [2nd] [VAR]. The display shows **NAME?**
2. Press [=/ENTER]. The display shows the name and value of the first variable (in alphabetical order) that has been defined. If more than one variable is defined, the ⇕ indicator appears.
3. Press [=/ENTER] or [2nd] [↓] to display the next variable, or press [2nd] [↑] to display the previous variable.

When you have finished reviewing variables, press [2nd] [EXIT] to return to the normal entry line.

Note: Any value in the list that has an exponent of less than −1 (such as the value .09) is displayed in scientific notation, regardless of the notation used to enter the value. For example, a variable stored as .004 is displayed as **4E-03**.

Editing the Value of a Variable

When you display a variable with the [2nd] [VAR] key sequence, you can edit its value by using [CLEAR], the cursor keys, [3rd] [DEL], [3rd] [INS], and the editing techniques described on pages 2-8 and 2-9.

Note: Pressing [CLEAR] while a variable is displayed only clears the displayed value; it does not set the variable value to zero. You must enter a value to continue reviewing the list of variables.

After editing the value, press [=/ENTER] to store the new value and display the next variable in the list.

Defining a New Variable with [2nd] [VAR]

1. When the **NAME?** prompt appears, press the alphabetical character for the new variable name. An = symbol appears next to the variable name.
2. Enter the value or expression that defines the variable and press [=/ENTER]. The TI-60X stores the value in the variable and displays the next defined variable in the list.

In the example below, one variable is defined before the equation is entered, and one variable is defined within the equation. The equation is then edited and re-evaluated, and the final result is stored in a variable.

Variables Example

Solve the following equation:

A ÷ B + 10 where A = 225, B = $(5^2 + 7)$

Store A in memory before entering the equation.

After evaluating the equation, edit the value of B to $(8^2 + 2.5)$, and re-evaluate the equation.

Store the final result in C. Then review the values of all the variables.

Procedure	Keystrokes	Display
Clear the entry line.	[CLEAR]	_
Define A.	225 [STO] A [=/ENTER]	225
Start equation.	[ALPHA] A [÷]	A÷
Enter expression for B and store it.	[(] 5 [x²] [+] 7 [)] [STO] B	← 5^2+7) STO B
Complete equation.	[+] 10 [=/ENTER]	17.03125
Redisplay equation.	[2nd] [EQU]	A÷(5^2+7) STO →
Change 5 to 8.	[→] [→] [→] 8	A÷(8^2+7) STO →
Change 7 to 2.5.	[→] [→] 2 [3rd] [INS] .5	INS → A÷(8^2+2.5) S
Re-evaluate.	[=/ENTER]	13.38345865
Store result in C.	[STO] C [=/ENTER]	13.38345865
Review variables.	[2nd] [VAR] A	⇕ A=225
	[=/ENTER]	⇕ B=66.5
	[=/ENTER]	⇕ → C=13.3834586
Exit variable list.	[2nd] [EXIT]	_

Managing Memory

In the TI-60X, memory is shared among variables, formulas, statistical data, simultaneous equations, and the last equation. You can delete data from memory as needed, as described on pages 4-8 and 4-9, to free memory space for new data.

How the TI-60X Uses Memory

The TI-60X has a maximum of 12 registers in which you can store variables, formulas, and statistical data. An additional five registers are available for entering an expression, except when you are solving simultaneous equations, entering two-variable statistical data, or integrating a formula.

For equations and formulas, each digit you enter occupies one of 15 character positions available in a register, and each operation you enter (such as +, √, or LOG) occupies two characters. Additionally, an equation requires a 4-character overhead and each formula requires a 6-character overhead.

Entering a set of two-variable statistical data leaves ten registers for variables and formulas and three registers for an expression. This limits the complexity of expressions you can evaluate with two-variable data in the statistical registers.

Entering and solving simultaneous equations requires all of the memory registers. Before entering simultaneous equations, you must reset the calculator's memory (described on page 1-7). While entering the coefficients, you have a minimum of three registers for an expression.

The memory requirements for different types of operations are shown below.

Task/Operation	Number of Registers Required
Storing a variable.	1
Entering and evaluating an equation.	1 per every 12 characters (approximately)
Storing and solving a formula.	1 per every 12 characters (approximately), and 1 for storing the result variable (see page 4-2)
Entering and solving simultaneous equations.	All 12 (temporarily)
Entering two-variable statistical data.	2

Checking Available Memory

To check the remaining amount of memory at any time, press [2nd] [CHK M]. The display shows the number of registers currently available for storage.

For example, if you have 10 registers available, the display shows **10 REG AVAIL**.

Memory Messages

If you approach the memory limits while entering data, the calculator lets you know by changing the cursor from an underscore (_) to a block (■).

If an operation requires more memory than is available, one of two messages is displayed: **CLR XX REG**, where XX represents the number of registers you should clear, or **REGS IN USE**. (The specific situations for each message are listed on page A-14.) You can clear either message by pressing [CLEAR]. To proceed with the operation, you must clear one or more registers by deleting variables, formulas, or the statistical registers.

Deciding What to Delete

If you need to clear some registers before proceeding with an operation, consider these suggestions:

- If you have stored two-variable statistical data that you no longer need, you can clear two registers by pressing [3rd] [CS].
- When deleting variables to clear memory space, you may first want to delete any that are not used in formulas. You regain one register for each variable you delete.
- Remember that, when you solve a formula, a variable with the same name as the formula is created. If you delete the variable, you can easily redefine it later by solving the formula again.

Instead of resetting the calculator, which clears all the data stored in memory, you can delete specific variables and formulas or stored statistical data. These two pages describe the procedures for deleting selected data from memory.

Deleting All Variables

To delete all your defined variables:

1. Press [3rd] [CVs] (Clear Variables).

   The prompt **CLR YN?** appears.

2. Press [YES] to clear all the variables, or press [NO] to leave the variables unchanged.

Deleting a Specific Variable

To delete one or more variables by name:

1. Press [2nd] [VAR]. The **NAME?** prompt is displayed. You can either:

   - Press [=/ENTER]. Then press [=/ENTER], [2nd] [↓], or [2nd] [↑] until the variable you want to delete is displayed.
   - Press the character for the variable name.

2. When the variable is displayed, press [3rd] [CFV] (Clear Formula or Variable). The **CLR YN?** prompt is displayed.

   - To delete the variable, press [YES]. The message **CLEARED** is displayed.
   - To keep the variable, press [NO]. The variable is displayed again.

3. If you wish, press [=/ENTER], [2nd] [↓], or [2nd] [↑] to continue going through the list of variables.

4. When you have deleted all the variables you want, press [2nd] [EXIT] to return to the normal entry line.

Deleting a Formula

1. Press [2nd] [FMLA]. The **NAME?** prompt is displayed. You can either:

   - Press [=/ENTER] and then press [2nd] [↓] or [2nd] [↑] until the formula you want to delete is displayed.
   - Press the character for the formula name.

2. When the formula is displayed, press [3rd] [CFV] (Clear Formula or Variable). The **CLR YN?** prompt is displayed.

   - To delete the formula, press [YES]. The message **CLEARED** is displayed.
   - To keep the formula, press [NO]. The formula is displayed again.

3. If you wish, press [2nd] [↓] or [2nd] [↑] to review and/or delete other formulas.

4. When you have deleted all the formulas you want, press [2nd] [EXIT] to return to the normal entry line.

Deleting Statistical Data

Press [3rd] [CS] (Clear Statistics). The **CLR YN?** prompt is displayed.

- To delete the statistical data, press [YES]. The message **CLEARED** is displayed and the **STAT** indicator is erased. Press [CLEAR] or start entering an equation to return to the normal entry line.
- To keep the data, press [NO]. The normal entry line is displayed.

The TI-60X lets you perform addition, subtraction, multiplication, and division directly on values stored in memory. You can use the STO function with arithmetic functions to change the value of a variable without affecting the result of the expression you are entering.

Performing Operations on a Variable

When you perform an arithmetic operation on a variable, the result of that operation replaces the previous contents.

Note: You can not perform memory math on an undefined variable.

The entry procedure for each memory operation is identical:

1. Enter the value with which to operate on the stored value.
2. Press [STO], and then press the math operation key.
3. Press the character for the variable name on which you want to operate. You don't have to press [ALPHA].

Example Keystrokes	Result (Stored in Variable)
17 [STO] [+] A	Adds 17 to previous contents of A.
200 [STO] [−] A	Subtracts 200 from previous contents of A.
9 [STO] [×] B	Multiplies previous contents of B by 9.
7 [STO] [÷] B	Divides previous contents of B by 7.

The result of the operation is stored when you press [=/ENTER] to evaluate the expression.

Chapter 5: Formula Programming

The TI-60X's formula routine provides a simple way of programming the calculator. This chapter contains the information needed to create, store, and evaluate formulas. There are also several examples that demonstrate formula programming.

Chapter Contents

General Information about Formulas

A formula is an expression that you define, name, and store for repeated use. An equation is an expression that you enter for immediate evaluation. There are several other differences in the way the calculator handles equations and formulas.

Differences Between Equations and Formulas

Equations	Formulas
Best for quick, one-time results involving short expressions.	Best for repeated solutions to similar problems and solutions to problems with longer expressions.
Result not automatically stored as a variable, although it is available through the "last answer" feature ([2nd] [ANS]).	Solution automatically stored in a variable with the same name as the formula. Solution also available as "last answer."
Last-evaluated equation is available through the "last equation" feature, provided you have not begun entering a new equation.	Always available with [2nd] [FMLA] unless you delete them or reset the calculator.
All variables to be used in the equation must be defined before you enter the equation.	Formula routine prompts you to enter the values of variables after you enter the formula.

Formula Names

When you press [2nd] [FMLA] to begin the formula routine, you specify a formula name consisting of a single alphabetical character. You can choose from the characters A–I, X, Y, and Z. You do not have to press [ALPHA] before pressing the character key.

Exiting from the Formula Routine

There are several ways to exit from the formula routine.

- Pressing [2nd] [EXIT] leaves the formula routine and returns to the entry-line display.
- Pressing [2nd] [OFF] turns the calculator off. When you turn the calculator on again, it is no longer in the formula routine.
- If you press [2nd] [FMLA] and display the **NAME?** prompt by accident, you can press any key sequence that starts another prompted routine to exit the formula routine and begin the new routine.

Displaying the List of Formulas

To display all the currently stored formulas, follow this procedure:

1. Press [2nd] [FMLA] to begin the formula routine.
2. Press [=/ENTER] or [2nd] [↓] to display the first formula in the list. (Formulas are stored alphabetically by name.)
3. Continue pressing [2nd] [↓] or [2nd] [↑] to view any remaining formulas.

Note: Anytime you are viewing a formula—even while entering it—you can use [2nd] [↓] or [2nd] [↑] to examine your other formulas. If you need more memory for a new formula, for example, you can look for a formula you no longer need, delete it, and then finish entering the new formula.

Creating and Evaluating a Formula

The procedure on these pages shows you how to enter and evaluate a new formula that has not been previously stored. The formula routine prompts you through the entry and evaluation of your formula.

Entering and Evaluating a Formula

1. Press [2nd] [FMLA] to begin the formula routine. The **NAME?** prompt appears.
2. Press a single alphabetical character (A–I, X, Y, or Z) to name your formula. You do not have to press [ALPHA] before pressing the character key.
3. Enter the expression for the formula, and press [=/ENTER]. The **SOLVE YN?** prompt appears in the display.
4. Respond to the **SOLVE YN?** prompt:
   - Press [NO] to store the formula without solving it and exit from the formula routine.
   - Press [YES] to solve the formula. The prompt for the first variable is displayed. The prompt consists of the variable name followed by = with a flashing cursor.
5. Define each of the formula's variables by entering a value, an expression, or the name of a previously defined variable.
6. Press [=/ENTER] to move to the next variable. When the last variable is defined, the **REVIEW YN?** prompt appears.
7. Respond to the **REVIEW YN?** prompt:
   - Press [YES] to review the formula's variables. As each variable is displayed, you may change it or press [=/ENTER] to accept it and move to the next variable. When the last variable is displayed, **REVIEW YN?** appears again.
   - Press [NO] to solve the formula. When the evaluation is completed, the result is displayed.

Example: Finding the Area of a Circle

By creating a formula, you can program the TI-60X to find the area of a circle with any radius. If a variable in this example is displayed with a value left over from previous examples, use the editing keys to change it.

Example

Find the area of a circle with a radius of 7cm.

The formula for finding the area of a circle is:

$A = \pi r^2$

Enter the formula as $A = \pi \times B^2$ where:

A = area of the circle.
B = radius of the circle.

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	_
Begin formula routine.	[2nd] [FMLA]	NAME?
Enter formula name.	A	A=_
Enter formula.	[π] [×] [ALPHA] B [x²] [=/ENTER]	SOLVE YN?
Evaluate formula.	[YES]	B=_
Enter radius.	7 [=/ENTER]	REVIEW YN?
Solve—no review.	[NO]	A= 153.93804

The area of the circle is 153.93804cm².

You can use the SOLVE key to save keystrokes when you have defined all your variables and to quickly solve a formula for several different values of the same variable.

Using the SOLVE Key to Bypass Prompts

You can use the SOLVE key to bypass the **SOLVE YN?** and **REVIEW YN?** prompts. If you have defined all the variables in your formula and do not wish to review them, use SOLVE to bypass the review process. You can also review some of the variables and then use SOLVE to bypass the rest.

1. With the formula displayed, press SOLVE.

   - If the formula contains variables, the first variable in the formula appears.

     If necessary, enter or edit the variable, pressing =/ENTER to accept the value for the variable and display the next variable. Review and edit as many of the variables as you wish.

   - If there are no variables, the formula is evaluated and the result is displayed.

2. Press SOLVE to evaluate the formula and display the solution.

Using the SOLVE Key to Repeat a Formula

You may need to evaluate a formula for several values of the same variable (see the example on the next page). If possible, arrange the formula so that the variable that will change for each evaluation occurs ahead of the other variables. You will then be prompted for the changing variable first. Since the other variables need no changes, you can then use SOLVE to bypass them and solve the formula.

When the solution appears, press SOLVE to repeat the evaluation. To use this feature, you must press SOLVE before pressing any other key.

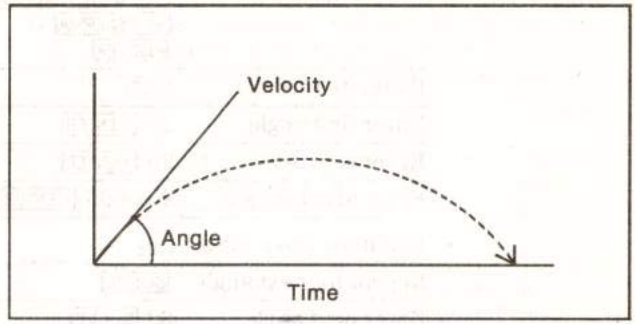
Note: If you use SOLVE to bypass variables you have not yet defined, an error condition occurs.

This example demonstrates how to use SOLVE to repeat a formula, changing one variable each time. If a variable in this example is displayed with a value left over from previous examples, use the editing keys to change it.

Problem Statement

Calculate the flight time of a projectile fired from ground level and traveling over level terrain, given the following variables:

C (firing velocity) = 20m/sec
G (gravitational acceleration) = 9.80665m/sec^2
A (angle of elevation): Solve for 20°, 60°, and 89°.



Use the formula:

B (flight time) = sin A × 2 × C ÷ G.

(continued)

Example: Calculating the Flight Time of a Projectile (Continued)

Formula

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	_
Set angle unit to degrees.	Press [3rd] [DR>] until **R** disappears.	_
Begin formula routine.	[2nd] [FMLA] B	B=_
Enter formula.	[SIN] [ALPHA] A [×] 2 [×] [ALPHA] C [÷] [ALPHA] G [=/ENTER]	SOLVE YN?
Evaluate formula.	[YES]	A=_
Enter first angle.	20 [=/ENTER]	C=_
Enter velocity.	20 [=/ENTER]	G=_
Enter acceleration.	9.80665 [=/ENTER]	REVIEW YN?
Evaluate—no review.	[NO]	B=1.39505394
Repeat for next angle.	[SOLVE]	A=20
Enter next angle.	60 [SOLVE]	B=3.53240058
Repeat for next angle.	[SOLVE]	A=60
Enter next angle.	89 [SOLVE]	B=4.07824362

The flight times for the projectile are: for 20°, 1.395 seconds; for 60°, 3.532 seconds; and for 89°, 4.078 seconds.

Recalling and Editing a Formula

You can recall a formula by name, or you can recall the list of all currently stored formulas. Anytime a formula is displayed, you can edit or delete it. Refer to Chapter 2 for more details about editing and Chapter 4 for details about deleting.

Recalling a Formula

Begin the formula routine by pressing [2nd] [FMLA].

- To recall a formula by name, respond to the **NAME?** prompt by pressing the character (A–I, X, Y, or Z) that is the formula name.
- To find a formula among all the currently stored formulas, respond to the **NAME?** prompt by pressing [=/ENTER] or [2nd] [↓] to display the first formula in the list (formulas are listed alphabetically by name), or [2nd] [↑] to display the last formula in the list. Continue pressing [2nd] [↑] or [2nd] [↓] to see any remaining formulas.

Editing a Formula

When the formula is displayed, you can edit it by using [CLEAR], the cursor keys, [3rd] [DEL], [3rd] [INS], and the editing techniques described on pages 2–8 and 2–9.

Deleting a Formula

With the formula in the display, press [3rd] [CFV]. The prompt **CLR YN?** appears. Press [YES] to delete the formula. The message **CLEARED** is displayed. Press [NO] to return the formula to the display without deleting it.

Using the Result of One Formula in Another

When you solve a formula, the calculator stores the result in a variable with the same name as the formula. By using that variable in a second formula, you can link the first formula to the second. An example of this is shown on the next page.

Considerations for Linking Formulas

Here are some facts to consider when you link two formulas together by using the result of one formula in another.

- The second formula uses the most recently evaluated result of the first formula.
- The first formula is not re-evaluated automatically when you evaluate the second formula.

Benefits of Linking Formulas

Some reasons you may want to link formulas include:

- Linking gives you a way to examine intermediate results.
- By linking, you can break your formulas into small, logical modules that may be usable in several subsequent formulas.
- After evaluating the first of the smaller formulas, you can accept its result unchanged in subsequent formulas, rather than having to re-enter the value for each formula.

A Variation of Linking

For some iterative calculations, you can use a formula's result as a variable within the formula itself (for example, $A = A + B^2$). After assigning an initial value to variable A, you can repeatedly solve this formula, accepting the newly calculated value of variable A at each iteration.

Example: Calculating the Capacity of a Freight Elevator

This example uses the solution of one formula in a second formula. If a variable in this example is displayed with a value left over from previous examples, use the editing keys to change it.

Problem Statement

Calculate the number of 60-kg boxes that can be lifted by a freight elevator, given the following variables:

A (motor power) = 50,000w
B (mass of each box) = 60kg
C (velocity) = 1m/sec
D (distance) = 200m
E (mass of empty elevator) = 500kg
G (gravitational acceleration) = $9.80665 m/sec^2$

You can use two formulas: one to calculate the work and a separate one to calculate the number of boxes the elevator can lift.

X (work in Newton • meters) = A × D ÷ C
Y (number of boxes) = (X ÷ D ÷ G − E) ÷ B

First Formula

Procedure	Keystrokes	Display
Reset calculator.	[3rd] [RESET] [YES]	CLEARED
Begin formula routine.	[2nd] [FMLA] X	X=_
Enter formula.	[ALPHA] A [×] [ALPHA] D [÷] [ALPHA] C [SOLVE]	A=_
Enter power.	50000 [=/ENTER]	D=_
Enter distance.	200 [=/ENTER]	C=_
Enter velocity and solve.	1 [SOLVE]	X= 10000000

The work performed (10,000,000 Newton • meters) is now stored as variable X. You can use X in the second formula.

(continued)

Second Formula

Procedure	Keystrokes	Display
Begin formula routine.	[2nd] [FMLA] Y	Y=_
Enter formula.	[(] [ALPHA] X [÷] [ALPHA] D [÷] [ALPHA] G [−] [ALPHA] E [)] [÷] [ALPHA] B [SOLVE]	X= 10000000
Accept work.	[=/ENTER]	D= 200
Accept distance.	[=/ENTER]	G=_
Enter gravitational acceleration.	9.80665 [=/ENTER]	E=_
Enter mass of empty elevator.	500 [=/ENTER]	B=_
Enter mass of one box and evaluate formula.	60 [SOLVE]	Y=76.6430177

The elevator capacity is 76 boxes.

Example: Interpolating Data in a Table

This example shows you how to use a formula to interpolate a value between two given values in a table. If you prefer to solve this type of problem using linear regression, refer to the similar example on page 8-10.

Formula

A table contains these values:

If A =	Then B =
1.04	0.8508
1.05	0.8531

You want to interpolate a B value where A = 1.044.

The formula that interpolates a desired value, B, between two values in a table can be entered as:

B = (A − D) ÷ (C − D) × (E − F) + F where

A = the A value for which you want to interpolate B.
C = the table value above A.
D = the table value below A.
E = the B value in the table at C.
F = the B value in the table at D.

Example

Procedure	Keystrokes	Display
Reset calculator.	[3rd] [RESET] [YES]	CLEARED
Begin formula routine.	[2nd] [FMLA] B	B=_
Enter the formula.	[(] [ALPHA] A [−] [ALPHA] D [)] [÷] [(] [ALPHA] C [−] [ALPHA] D [)] [×] [(] [ALPHA] E [−] [ALPHA] F [)] [+] [ALPHA] F [=/ENTER]	SOLVE YN?
Evaluate the formula.	[YES]	A=_
Enter value for A.	1.044 [=/ENTER]	D=_
Enter value for D.	1.05 [=/ENTER]	C=_
Enter value for C.	1.04 [=/ENTER]	E=_
Enter value for E.	.8508 [=/ENTER]	F=_
Enter F and evaluate.	.8531 [SOLVE]	B= 0.85172

Chapter 6: Integration

With a series of prompts, the TI-60X guides you through integration, the process of estimating a specified area under a curve. This chapter describes the integration procedure and includes examples for integration.

Chapter Contents

Before Integrating a Formula

The integration routine is a specialized branch of the formula routine. The TI-60X uses Simpson's Rule to calculate an integral.

Requirements for Integrating a Formula

The values you enter in the integration routine must be real, decimal values.

If the formula to be integrated contains trigonometric functions, you must select the appropriate angle unit setting (degrees or radians) for correct results.

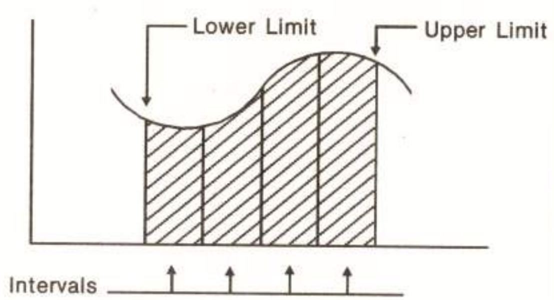
The [2nd] [dx] key sequence is used to indicate the independent variable during the formula routine's prompting sequence. You can integrate on only one variable. An error will occur if **dx** is used to respond to more than one variable prompt in a formula.

How the Calculator Integrates

The integration routine operates on a formula that you enter. It evaluates your formula at several sample points and uses Simpson's Rule to determine the areas of the intervals. (See Appendix A for more information on Simpson's Rule.)

In the formula routine, you are prompted to define the formula's variables. You may select one variable to integrate on (independent variable) by pressing [2nd] [dx] in response to the variable prompt.

The integration routine then prompts you for the upper and lower limits of the independent variable and the number of intervals.



When you press [=/ENTER] or [SOLVE], the integrated solution is calculated and displayed, and the upper limit (or its nearest calculated equivalent) is stored in the independent variable.

Trigonometric Integrals

Tables of trigonometric integrals are usually based on radian angles. To obtain the same answer when integrating on the calculator, you must select radians as the angle unit before performing the integration.

To evaluate the integral between limits in a table of trigonometric integrals, you find its value at the upper limit and subtract its value at the lower limit.

Although a function may not contain any trigonometric functions, its integral may be an inverse trigonometric function. For such a function, the answer is in terms of radians, regardless of the angle-unit setting.

For example, the indefinite integral of $1/\sqrt{2x-x^2}$ is $\cos^{-1}(1-x)$. If you evaluate

$$\int_1^{1.5} (1/\sqrt{2x-x^2})dx$$

with the integration feature using 25 intervals, you get 0.523598776, regardless of the angle-unit setting. But if you evaluate

$$\cos^{-1}(1-x)\Big]_1^{1.5} = \cos^{-1}(1-1.5) - \cos^{-1}(1-1)$$

you must set the calculator to radians to get the same answer (0.523598776).

Follow the steps on these pages to integrate a formula. A series of prompts for integration is initiated when you identify the independent variable during the formula routine. The formula can be one that you are currently entering or one that you have stored.

Steps for Integrating a Formula

1. Press [2nd] [FMLA] to begin the formula routine. Then enter a new formula or display a previously stored formula and press [SOLVE].
2. Define each variable and press [=/ENTER]. (Do not press [SOLVE] to bypass the variable prompts.) When you are prompted for the independent variable, press [CLEAR] to clear the current value, and then press [2nd] [dx] [=/ENTER].
3. The integration prompts are displayed one at a time:
   - LOW= prompts for the lower limit. Enter the lower limit and press [=/ENTER].
   - UP= prompts for the upper limit. Enter the upper limit and press [=/ENTER].
   - INTRV= prompts for the number of intervals. Enter the number as an integer from 1 through 99 and press [=/ENTER]. (In accordance with Simpson's Rule, the calculator uses twice this number of subintervals.)

     Note: Calculation speed is affected by the number of intervals.

   Continue defining variables until the REVIEW YN? prompt appears.
4. When REVIEW YN? is displayed:
   - Press [NO] or [SOLVE] to solve the integrated formula.
   - Press [YES] to review the variables, including the independent variable's upper and lower limits and the number of intervals.

   The message CALC is displayed while the calculator integrates. The integral is displayed and stored in a variable with the same name as the formula. The upper-limit value you entered (or its nearest calculated equivalent) is now stored in the variable you declared as the independent variable.

Example: Integrating a Simple Polynomial

This example demonstrates the integration of a simple function both manually and on the calculator. If a variable in this example is displayed with a value left over from previous examples, use the editing keys to change it.

Integrating Manually

Integrate the function a = $4x^3$ with respect to x, using a lower limit of .5 and an upper limit of 1.5.

$$a = \int_{.5}^{1.5} 4x^3\,dx$$

The integral is $a = (x^4)_{.5}^{1.5} = 1.5^4 - .5^4 = 5$.

Integrating on the Calculator

Enter the formula into the calculator as

A = 4 × Xy^x3

and integrate it using 4 intervals.

Procedure	Keystrokes	Display
Clear the entry line.	[CLEAR]	
Begin formula routine.	[2nd] [FMLA] A	A=_
Enter the formula.	4 [×] [ALPHA] X [y^x] 3	A=4×Xy^x3
Integrate.	[SOLVE]	X=_
Declare X to be the independent variable.	[CLEAR] [2nd] [dx] [=/ENTER]	LOW=_
Enter the lower limit.	.5 [=/ENTER]	UP=_
Enter the upper limit.	1.5 [=/ENTER]	INTRV=_
Specify 4 intervals.	4 [=/ENTER]	REVIEW YN?
Calculate the result.	[NO]	A= 5

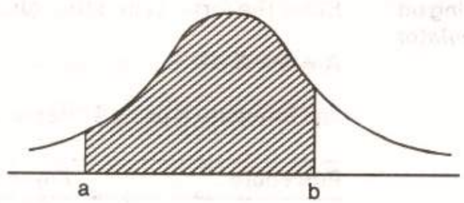
Example: Integrating an Area Under the Standard Normal Curve

This example calculates an area between given boundaries under the standard normal curve. If a variable in this example is displayed with a value left over from previous examples, use the editing keys to change it.

Background Information

The probability that a standard normal variate, Z, falls within the interval (a,b) is:

$$P(a \le Z \le b) = \frac{1}{\sqrt{2\pi}} \int_a^b e^{-Z^2/2}\,dz$$



The formula can be expressed as:

$f(Z) = (2\pi e^{Z^2})^{-.5}$.

You can enter this formula into the calculator as:

$F = (2\pi e^{Z^2})^{-.5}$

where Z is the variable to be integrated on (independent variable).

Example

Find the probability that a standard normal variate falls in the range from −1 (lower limit) to +1 (upper limit). Use 3 as the number of intervals.

Note: If you have entered previous examples, you may need to clear memory by pressing [3rd] [RESET] [YES] before starting this example.

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	—
Begin formula routine.	[2nd] [FMLA] F	F=_
Enter formula.	[(] 2 [×] [π] [×] [2nd] [eˣ] [ALPHA] Z [x²] [)] [yˣ] [(-)] .5 [=/ENTER]	SOLVE YN?
Choose to solve.	[YES]	Z=_
Declare independent variable.	[CLEAR] [2nd] [dx] [=/ENTER]	LOW=_
Enter lower limit.	[(-)] 1 [=/ENTER]	UP=_
Enter upper limit.	1 [=/ENTER]	INTRV=_
Specify 3 intervals.	3 [=/ENTER]	REVIEW YN?
Integrate formula.	[NO]	F=0.68275861

The probability that Z falls within one standard deviation of the mean is about 68%.

Chapter 7: Simultaneous Equations

You can solve second- and third-order systems of simultaneous linear equations using the TI-60X. This chapter includes the procedures for ordering, entering, and solving simultaneous equations, as well as some useful examples.

Chapter Contents

Background on Simultaneous Linear Equations

Describing a physical situation often requires more than one equation. A set of two or more linear equations that impose conditions simultaneously on a set of unknowns is called a system of linear equations.

Systems of Linear Equations

A linear equation can have any number of unknowns. For example,

$$5x - 2y = 13$$
$$x + 3y = 23$$

is a second-order system (two equations in two unknowns), and

$$x + .5y - .4z = 4.8$$
$$3x - 4y + 2z = 7$$
$$2x + 3y + 2z = 44$$

is a third-order system (three equations in three unknowns). The TI-60X solves second- and third-order systems.

Note that the unknowns of a linear equation only occur to the first power.

Solutions to Systems of Linear Equations

The solution to a system of equations is a set of values for the unknowns that solves each equation. To solve for each unknown, there must be as many equations in the system as there are unknowns.

Solutions are displayed in standard notation with a floating decimal point, regardless of the currently selected display format and fix-decimal setting.

A system of linear equations may have one set of solution values, no solution, or many solutions. If there is no solution or more than one set of solutions, the TI-60X displays the **ERROR** message.

If the **ERROR** message appears when you solve simultaneous equations, you can press [2nd] [EQU] or [CLEAR] to review and edit the coefficients, or press [2nd] [EXIT] to exit.

Note: Very large coefficients can also cause an error. In this case, pressing [2nd] [EQU] or [CLEAR] exits the simultaneous equations routine.

Before Solving Simultaneous Equations

Write your simultaneous equations with the terms (x, y, z) in rows and columns. The simultaneous equations routine uses the row/column subscript to identify each coefficient. The calculator prompts you for each coefficient and stores results as variables.

Expressing a System of Equations

You may need to rearrange your equations to fit the following row/column order:

Second-Order System

$$a_{11}x + a_{12}y = b_1$$
$$a_{21}x + a_{22}y = b_2$$

Third-Order System

$$a_{11}x + a_{12}y + a_{13}z = b_1$$
$$a_{21}x + a_{22}y + a_{23}z = b_2$$
$$a_{31}x + a_{32}y + a_{33}z = b_3$$

You must enter a zero as the coefficient for any term that is missing from your equations.

Requirements for Entering Coefficients

Consider these facts when entering coefficients for simultaneous equations:

- The coefficients must be real, decimal values, fractions, or expressions that evaluate to real, decimal values.
- You cannot use the store and exchange functions while entering coefficients. The results, however, are stored as variables X, Y, and (for third-order equations) Z.

Solving Simultaneous Equations

Having ordered your equations, you are now ready to enter and solve them. This preparation is especially useful because you cannot recall equations once you have solved them. You can, however, review the coefficients as many times as you need to before solving.

Entering and Evaluating a System of Simultaneous Equations

Before entering, you may want to review your equations to make sure they match the order in which the prompts in the simultaneous equations routine occur.

Follow these steps to enter and solve simultaneous equations. Examples begin on page 7-6.

1. Press [3rd] [RESET] [YES] to clear all stored data and select the decimal number base. The simultaneous equations routine requires all memory used by variables, formulas, and statistics data.
2. Press [2nd] [SIMUL] to begin the simultaneous equations routine. The prompt **EQUA 2 OR 3?** is displayed.
3. Press 2 for second order equations or 3 for third order.

   The prompts for the coefficients begin (a_{11}, a_{12}, etc.).
4. Enter your coefficients according to the prompts.

   If you need to exit the routine while entering coefficients, press [2nd] [EXIT] or [2nd] [OFF].

Entering and Evaluating Simultaneous Equations (Continued)

5. When all the coefficients are entered, the display shows **REVIEW YN?**.
   - Press [YES] to review the coefficients. During review, press [=/ENTER] or [2nd] [↓] to move through the list of coefficients.
   - Press [NO] or [SOLVE] to solve the equations. The first variable in the solution set (x) is displayed.
6. Press [=/ENTER], [2nd] [↑], or [2nd] [↓] to display each solution.
7. Exit by pressing [CLEAR] or [2nd] [EXIT] while reviewing the solution set.

Note: Unlike calculations that display a single result, the simultaneous equations routine displays a list of results. You must exit the solution set before you can perform other calculator operations.

Revising a Coefficient While Reviewing the Entered Data

You can change the coefficients before solving the equations. When the **REVIEW YN?** prompt appears, press [YES]. You can then edit a coefficient by using [CLEAR], the cursor keys, [3rd] [DEL], [3rd] [INS], and the editing techniques described on pages 2-8 and 2-9.

Note: Pressing [CLEAR] while a coefficient is displayed only clears the displayed value; it does not set the coefficient to zero. You must enter a value to continue reviewing the list of coefficients.

After editing the value, press [=/ENTER] to accept the new value and display the next coefficient in the list.

This example shows how to enter and evaluate a simple system of two linear equations.

Problem Statement

Given the following second-order system:

5x − 2y = 13
x + 3y = 23

solve for the two unknowns.

Solution

Procedure	Keystrokes	Display
Reset calculator.	[3rd] [RESET] [YES]	CLEARED
Begin entry sequence.	[2nd] [SIMUL]	EQUA 2 OR 3?
Specify 2nd order.	2	a11=_
Enter the row 1, column 1 coefficient.	5 [=/ENTER]	a12=_
Enter the coefficient.	[(-)] 2 [=/ENTER]	b1=_
Enter the row 1 solution.	13 [=/ENTER]	a21=_
Enter the row 2, column 1 coefficient.	1 [=/ENTER]	a22=_
Enter the coefficient.	3 [=/ENTER]	b2=_

(continued)

Solution (continued)

Procedure	Keystrokes	Display
Enter the row 2 solution.	23 [=/ENTER]	REVIEW YN?
Show X solution.	[NO]	▲▼ X=5
Show Y solution.	[=/ENTER]	▲▼ Y=6
Leave solution set.	[CLEAR]	—

In this system of equations, x is equal to 5, and y is equal to 6.

Example: Analyzing a Manufacturing Problem

This example shows how to analyze a manufacturing situation by solving a system of three linear equations.

Problem Statement

A small manufacturing company produces three types of products. Three departments, assembly, testing, and packaging, are required to produce each product, with the amount of time shown in the table below.

Department	Product X (Hrs./unit)	Product Y (Hrs./unit)	Product Z (Hrs./unit)
Assembly	0.3	0.4	0.2
Testing	0.2	0.3	0.2
Packaging	0.1	0.2	0.1

The assembly department has 340 work-hours available each week; the testing department has 280 hours available each week; and the packaging department has 160 hours available each week. If the company operates at full capacity, how many of each product can be produced every week?

Solution

The system of equations is:

$$.3x + .4y + .2z = 340$$
$$.2x + .3y + .2z = 280$$
$$.1x + .2y + .1z = 160$$

Procedure	Keystrokes	Display
Reset calculator.	[3rd] [RESET] [YES]	CLEARED
Begin entry sequence.	[2nd] [SIMUL]	EQUA 2 OR 3?
Specify 3rd order.	3	a11=_
Enter the row 1, column 1 coefficient.	.3 [=/ENTER]	a12=_
Enter the coefficient.	.4 [=/ENTER]	a13=_
Enter the coefficient.	.2 [=/ENTER]	b1=_
Enter the row 1 solution.	340 [=/ENTER]	a21=_

Solution (Continued)

Procedure	Keystrokes	Display
Enter the row 2, column 1 coefficient.	.2 [=/ENTER]	a22=_
Enter the coefficient.	.3 [=/ENTER]	a23=_
Enter the coefficient.	.2 [=/ENTER]	b2=_
Enter the row 2 solution.	280 [=/ENTER]	a31=_
Enter the row 3, column 1 coefficient.	.1 [=/ENTER]	a32=_
Enter the coefficient.	.2 [=/ENTER]	a33=_
Enter the coefficient.	.1 [=/ENTER]	b3=_
Enter the row 3 solution.	160 [=/ENTER]	REVIEW YN?
Show X solution.	[NO]	⬍ X=200
Show Y solution.	[=/ENTER]	⬍ Y=400
Show Z solution.	[=/ENTER]	⬍ Z=600
Leave solution set.	[CLEAR]	—

Each week, the company can manufacture 200 of Product X, 400 of Product Y, and 600 of Product Z.

Example: Analyzing a Resistance Network

The techniques of node analysis and mesh analysis can be used to analyze a resistance network. This example uses node analysis to solve the voltages at all nodes in a circuit of resistors. To use node analysis, write equations based on the fact that the algebraic sum of currents flowing into a node is equal to zero.

Principle

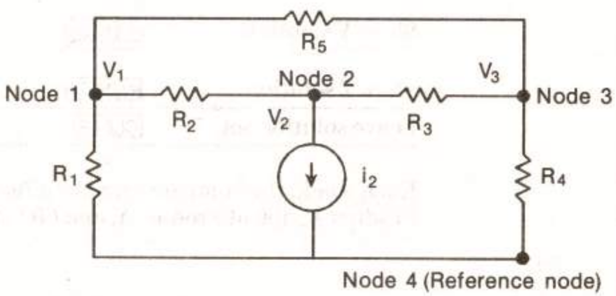
Any circuit has two or more nodes. Components are connected between the nodes to form current paths. The current entering a node must equal the current leaving the node. One node is the reference node for voltage measurements across components. The current in an individual current path is defined as either of the following:

- The reciprocal of the resistance (1/R) multiplied by the voltage (v) across that component.
- The value of a current source in that path.

To write a system of simultaneous equations describing the circuit, place all the $1/R \times v$ terms on one side of the = sign, and place all the current-source terms on the other side.

Problem Statement

The following circuit has four nodes.



The current equations at the nodes are:

Node 1: $\frac{1}{R_1} v_1 + \frac{1}{R_2}(v_1 - v_2) + \frac{1}{R_5}(v_1 - v_3) = 0$

Node 2: $\frac{1}{R_2}(v_2 - v_1) + \frac{1}{R_3}(v_2 - v_3) = -i_2$

Node 3: $\frac{1}{R_4} v_3 + \frac{1}{R_3}(v_3 - v_2) + \frac{1}{R_5}(v_3 - v_1) = 0$

(continued)

Problem Statement (Continued)

Regrouping the coefficients of voltage yields:

$$\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_5}\right)v_1 + \left(\frac{-1}{R_2}\right)v_2 + \left(\frac{-1}{R_5}\right)v_3 = 0$$

$$\left(\frac{-1}{R_2}\right)v_1 + \left(\frac{1}{R_2} + \frac{1}{R_3}\right)v_2 + \left(\frac{-1}{R_3}\right)v_3 = -i_2$$

$$\left(\frac{-1}{R_5}\right)v_1 + \left(\frac{-1}{R_3}\right)v_2 + \left(\frac{1}{R_3} + \frac{1}{R_4} + \frac{1}{R_5}\right)v_3 = 0$$

Given the following values,

$R_1 = 1000\,\Omega$	$R_4 = 85\,\Omega$
$R_2 = 400\,\Omega$	$R_5 = 2000\,\Omega$
$R_3 = 200\Omega$	$i_2 = .01$ a

Solve the system of equations for v_1, v_2, and v_3.

Solution

Procedure	Keystrokes	Display
Reset calculator.	[3rd] [RESET] [YES]	CLEARED
Begin entry sequence.	[2nd] [SIMUL]	EQUA 2 OR 3?
Specify 3rd order.	3	a11=_
Enter a_{11} (the row 1, column 1 coefficient).	1000 [X-1] [+] 400 [X-1] [+] 2000 [X-1] [=/ENTER]	a12=_
Enter a_{12}.	[(-)] 400 [X-1] [=/ENTER]	a13=_
Enter a_{13}.	[(-)] 2000 [X-1] [=/ENTER]	b1=_
Enter b_1 (the row 1 solution).	0 [=/ENTER]	a21=_

(continued)

Solution (Continued)

Procedure	Keystrokes	Display
Enter a_{21}.	[(-)] 400 [x-1] [=/ENTER]	a22=_
Enter a_{22}.	400 [x-1] [+] 200 [x-1] [=/ENTER]	a23=_
Enter a_{23}.	[(-)] 200 [x-1] [=/ENTER]	b2=_
Enter b_2.	[(-)] .01 [=/ENTER]	a31=_
Enter a_{31}.	[(-)] 2000 [x-1] [=/ENTER]	a32=_
Enter a_{32}.	[(-)] 200 [x-1] [=/ENTER]	a33=_
Enter a_{33}.	200 [x-1] [+] 85 [x-1] [+] 2000 [x-1] [=/ENTER]	b3=_
Enter b_3.	0 [=/ENTER]	REVIEW YN?
Show the X solution (v_1).	[NO]	↕ → X= -1.5443919
Show the Y solution (v_2).	[=/ENTER]	↕ → Y= -2.3272817
Show the Z solution (v_3).	[=/ENTER]	↕ → Z= -.71872668
Leave the solution set.	[CLEAR]	_

The voltages at the three nodes with respect to the reference node are approximately $v_1 = -1.54$, $v_2 = -2.33$, and $v_3 = -0.72$ volts.

Chapter 8: Statistics and Probability

The TI-60X performs one- and two-variable statistical calculations, including linear regression and trend-line analysis. You also can calculate combinations and permutations.

Chapter Contents

Before Entering Statistical Data

These pages contain background information for performing statistical analyses on the TI-60X.

Kinds of Data Sets

For one-variable (unpaired) data, each data point consists of a single number (x).

For two-variable (paired) data, each data point consists of two numbers (x and y). When entering two-variable data, you must separate x and y with a comma.

One-variable Examples	Two-variable Examples
5.5	3.1,7.8
5.3	2.1,6.9
5.0	2.5,6.8
5.8	3.4,7.0

For trend-line analysis, in which the value of x is incremented by 1 for each value of y, you only have to enter the first value of x.

Requirements for Entering Data Points

The numbers you enter as data points:

- Must evaluate to decimal values. Make sure the TI-60X is set to the decimal number base.
- Must all be one-variable or two-variable points. You cannot mix one- and two-variable data.
- May be either numeric values (including fractions, recalled variables, and "last answer") or simple expressions. For example, you could use 4+5.5÷12 to enter a length of 4 feet 5.5 inches. If you use a variable, it must be one you have already defined.

  Note: Due to the memory requirements of statistical calculations, expression complexity is limited to a maximum of two pending operations when the statistics registers contain data.

Overview of Statistical Calculations

Here is an overview of the process for entering data and calculating results. Detailed instructions are contained on the following pages, and examples begin on page 8-9.

- Clear the statistical data registers. This is necessary each time you start a new data set.
- Enter the data points. The TI-60X has features to help you enter trend-line data and recurring data points in the set.
- Press the keys for the results you want to display.

Kinds of Results

Anytime after entering the data set, you can display:

- The total number of data points entered.
- Mean and sample or population standard deviation.
- A list of summation results, such as the sum of the x values.
- Linear regression results, such as slope, intercept, and correlation coefficient (for two-variable data).

Storing a Statistical Result

Anytime a statistical result is displayed, you can store the value as a variable and then use the variable in an equation or formula.

To store the result, press [STO] and then press the key (A–I, X, Y, or Z) for the variable name.

Entering and Removing Statistical Data

The first time you press the [Σ+] key to enter a data point, the calculator shows the STAT indicator to let you know the statistical registers contain data. The indicator remains displayed until you clear the statistics registers.

Clearing the Statistical Data Registers

Before starting a new statistics problem:

1. Press [3rd] [CS] to clear the registers.

   The display shows **CLR YN?**

2. Press [YES] to clear or [NO] to cancel.

   If you press [YES], the display shows **CLEARED** and the **STAT** indicator is erased.

Entering Statistical Data

1. Enter the number, expression, or variable name for the x value of the first data point.
2. If entering two-variable data, press [,] and then enter the corresponding y value.
3. Use one of these methods to enter the point into the statistics registers:
   - If the data point occurs only once in the set, press [Σ+].
   - If the data point occurs in a few places in the set, press [Σ+] for each occurrence.
   - If the data point occurs many times, press [3rd] [FRQ], enter the number of occurrences (from 1 to 999), and then press [Σ+] to enter all the occurrences as a group.

   Each time you enter a data point, the calculator displays the total number of points entered (n).

4. Repeat steps 1 to 3 for each data point in the data set.

Note: Because sums are calculated as you enter data, entering large data points can exceed the calculator's range. If this happens, the calculator clears the statistics registers and the display shows **ERROR**. You may have to adjust the magnitude of each data point (dividing it by 1000, for example) before re-entering the data set.

Removing Data Points

To remove a data point immediately after pressing [Σ+], press [2nd] [Σ−]. The data point is removed and the display shows the adjusted number of data points.

To remove a data point after you have entered additional data:

1. Enter the same value, expression, or variable name you used to enter the x value of the data point. For two-variable data, press [,] and enter the value for y.
2. If applicable, use [3rd] [FRQ] to specify the number of occurrences you are removing.
3. Press [2nd] [Σ−].

   The data point is removed and the display shows the adjusted number of data points.

Note: If you use [2nd] [Σ−] to remove the only remaining data point, the **ERROR** message is displayed.

Entering and Removing Trend-Line Data

The TI-60X gives you a shortcut for entering two-variable data in which the value of x increases by 1 for each entered y value. You only have to enter the starting value of x. After that, you enter a comma in place of each x value; the calculator increments x by 1 and makes the x entry.

Entering Trend-Line Data

1. If appropriate, clear the statistical registers.
2. Enter the number, expression, or variable name for the starting x value and press [,].
3. Enter the first y value and press [Σ+].
4. Press [,]. The calculator increments x by 1 and displays the new value of x followed by the comma.
5. Enter the y value and press [Σ+] to enter the data point.
6. Repeat steps 4 and 5 for each data point in the set.

Note: The x values in your data set may have some breaks (for example, 15, 16, 17, 18, 20). You can enter the x value 15, use the [,] shortcut for x values 16, 17, and 18, and then enter the x value 20.

Removing Trend-Line Data

To remove a data point immediately after pressing [Σ+], press [2nd] [Σ−]. The data point is removed, x is reduced to its previous value, and the display shows the adjusted number of data points.

To remove a data point after you have entered additional data:

1. Enter the x and y values you used to enter the point.
2. Press [2nd] [Σ−].

   The data point is removed and the display shows the adjusted number of data points. To continue entering data, you must re-establish x by entering the next x value, pressing [,], and entering the y value.

Calculating Statistical Results

You can calculate a variety of commonly needed statistical results. For one-variable data, only the x results are calculated and displayed. If you need to save a result for later calculations, you can store it as a variable.

Calculating Mean, Standard Deviation, and Variance

Key Sequence	Result
[3rd] [n]	Number of data points
[2nd] [x̄] or [2nd] [ȳ]	Mean of x or y
[2nd] [σxn-1] or [2nd] [σyn-1]	Sample standard deviation of x or y
[2nd] [σxn-1] [x2] or [2nd] [σyn-1] [x2]	Sample variance of x or y
[2nd] [σxn] or [2nd] [σyn]	Population standard deviation of x or y
[2nd] [σxn] [x2] or [2nd] [σyn] [x2]	Population variance of x or y

Calculating Summation Results

Key Sequence	Result
[3rd] [Σx]	Sum of the x values
[3rd] [Σx2]	Sum of squares of x values
[3rd] [Σy]	Sum of the y values
[3rd] [Σy2]	Sum of squares of y values
[2nd] [Σxy]	Sum of products of x and y

(continued)

Calculating Linear-Regression Results

Key Sequence	Result
[3rd] [ITC]	y-Intercept of regression line
[3rd] [SLP]	Slope of regression line
[3rd] [COR]	Correlation coefficient
[3rd] [x'] *y* [=/ENTER]	Predicted x for a trial *y*
[3rd] [y'] *x* [=/ENTER]	Predicted y for a trial *x*

Note: When you press [3rd] [x'] or [3rd] [y'], the calculator displays x' or y', respectively, to show which variable you are predicting. Enter the value of the other (trial) variable and press [=/ENTER].

Adjusting the Correlaton Coefficient for Nonrandom Data

When sampling is at regular intervals, as in a trend-line analysis, x is not a random normal variable. With such nonrandom data in the data set, the correlation coefficient must be modified to accurately gauge the linearity of the data. To determine the "coefficient of determination," calculate the square of the correlation coefficient.

Considerations for Predicting x' and y'

Linear regression is best suited to making predictions within the range of measured data.

In particular, you should use caution in the following calculations:

- Calculating an x (independent) value based on a y (dependent) value.
- Calculating a y value based on an x that is outside the range of entered x values.

The resulting predictions may or may not have statistical validity, depending on the number of data points and their correlation coefficient. However, trend-line analysis and forecasting often use measured data to make predictions or estimations of probability about the future.

One-Variable Example: Analyzing a Sample

When analyzing a random sample of a population, you can describe the entire population by calculating the mean and "n−1 weighted" standard deviation of the sample.

Example

To find the average life (in hours ÷ 1000) for a manufactured lot of light bulbs, you have tested a random sample of 10 bulbs. The measurements are:

1900 hours (1 of the bulbs)
2000 hours (5 of the bulbs)
2100 hours (3 of the bulbs)
2200 hours (1 of the bulbs)

Calculate Σx, Σx², x̄, and σn−1.

Procedure	Keystrokes	Display
Clear the registers.	[3rd] [CS] [YES]	CLEARED
Enter the data, erroneously entering the last measurement as 22 instead of 2.2.	1.9 [Σ+] 2 [3rd] [FRQ] 5 [Σ+] 2.1 [3rd] [FRQ] 3 [Σ+] 22 [Σ+]	n= 10
Remove the error.	[2nd] [Σ−]	n= 9
Correct the error.	2.2 [Σ+]	n= 10
Show Σx.	[3rd] [Σx]	20.4
Show Σx².	[3rd] [Σx2]	41.68
Calculate mean.	[2nd] [x̄]	2.04
Calculate standard deviation.	[2nd] [σxn-1]	0.084327404

Using this sample, the average life is 2040 hours, and the standard deviation is about 84 hours.

Two-Variable Example: Linear Regression

This example uses linear regression to interpolate the speed of a moving object at a given point in time.

Example The following table contains sampled velocities for an object moving in a straight line at constant acceleration.

Time (sec)	Velocity (ft/sec)
1.0	120.7
3.5	171.9
7.5	254.4
10.0	305.1

Calculate the slope and intercept for the object, and estimate the velocity of the object at time 5 seconds.

Procedure	Keystrokes	Display
Clear the registers.	3rd [CS] YES	CLEARED
Enter the data.	1 , 120.7 Σ+ 3.5 , 171.9 Σ+ 7.5 , 254.4 Σ+ 10 , 305.1 Σ+	n= 4
Find slope.	3rd [SLP]	20.51134021
Find intercept.	3rd [ITC]	100.2126289
Calculate velocity at 5 seconds.	3rd [y'] 5 =/ENTER	202.7693299

Example: Trend-Line Analysis

In this example, a machine tool for manufacturing parts is measured for wear at regular intervals (after every 1000 parts made). Because the interval, when divided by 1000, gives x values of 1, 2, 3, and so on, you can take advantage of the TI-60X shortcut for entering trend-line data.

Example The following table represents wear measurements taken after every 1000 parts manufactured by a specific machine tool.

Parts Produced (in 1000s)	Tool Wear (in 1/1000 inch)
1	.9
2	1.25
3	1.31
4	2.15
5	2.25
6	2.75
7	3.06

Estimate the tool wear in 1/1000 inch per 1000 parts (slope), and estimate how many parts the tool will be able to manufacture before tool wear reaches an unacceptable level of .005 inches.

Procedure	Keystrokes	Display
Clear the registers.	3rd [CS] YES	CLEARED
Enter the data, specifying only the starting value of x.	1 , .9 Σ+ , 1.25 Σ+ , 1.31 Σ+ , 2.15 Σ+ , 2.25 Σ+ , 2.75 Σ+ , 3.06 Σ+	n= 7
Find average wear per 1000 parts.	3rd [SLP]	0.372142857
Estimate number of parts over tool life.	3rd [x'] 5 =/ENTER	12.18809981

The average wear is .000372 inch per 1000 parts, and the tool should produce 12,188 parts before reaching .005 inch of wear.

Calculating Combinations and Permutations

A combination is an arrangement of objects in which the order is not important, as in a poker hand. A permutation is an arrangement in which the order is important, as in a horse race. The TI-60X can calculate the number of possible combinations or permutations of *n* objects taken *r* at a time.

Entering Combinations and Permutations

To calculate the possible combinations of *n* objects taken *r* at a time, enter the value for *n*, press [2nd] [nCr], and enter the value for *r*.

To calculate the possible permutations, use the same sequence, but press [3rd] [nPr] instead of [2nd] [nCr].

Combination Example

Calculate the number of different 5-card poker hands that can be dealt from a deck of 52 cards.

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	—
Enter expression.	52 [2nd] [nCr] 5	52 nCr 5
Calculate combinations.	[=/ENTER]	2598960

Permutation Example

Calculate the number of possible permutations for the first-, second-, and third-place finishers (no ties) in an eight-horse race.

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	—
Enter expression.	8 [3rd] [nPr] 3	8 nPr 3
Calculate permutations.	[=/ENTER]	336

Chapter 9: Number Bases and Logic Operations

The TI-60X lets you enter decimal, hexadecimal, octal, or binary numbers and perform arithmetic calculations on them. You also can perform number-base conversions, and use Boolean logic operators, which are fundamental to computer programming.

Chapter Contents

Number Bases and Their Ranges

In the hexadecimal, octal, and binary number bases, the calculator truncates the fractional portion of all non-integer results. If the resulting integer value is beyond the limits for the selected number base, an error occurs.

Ranges of Values

This table lists the lower and upper limits for entered numbers and displayed results in the nondecimal number bases.

Base	Negative Limit	Positive Limit
Hex	FDABF41C01 (−9,999,999,999 decimal)	2540BE3FF (9,999,999,999 decimal)
Octal	4000000001 (−536,870,911 decimal)	3777777777 (536,870,911 decimal)
Binary	1000000001 (−511 decimal)	111111111 (511 decimal)

These limits do not apply to undisplayed, intermediate results during the evaluation of an expression.

For example, evaluating the expression FDABF41C01−3+6 displays the correct result even though the intermediate result of FDABF4C01−3 cannot be displayed.

If you enter a decimal point or a fraction in an expression while in a nondecimal number base, evaluating the expression causes an error condition. You can, however, recall non-integer variables or a non-integer last answer. The calculator truncates the fractional portion of the recalled number.

2's Complement

The 2's complement function is for entering negative numbers or negating numbers. As with the negate key [(-)], you must press [3rd] [2's] **before** entering the value.

Nondecimal Operations

In the nondecimal number bases, the TI-60X lets you perform most of the math operations available with decimal numbers.

Requirements for Nondecimal Values

These requirements apply to hexadecimal, octal, and binary numbers you enter.

- Press one of the key sequences [2nd] [HEX], [2nd] [OCT], or [2nd] [BIN] to select the appropriate number base before entering nondecimal numbers.
- Enter integers only. Attempting to use a decimal point in a nondecimal number base results in an error.
- Use only the digits that are applicable to the selected number base. Attempting to use an 8 or a 9 in the octal base, for example, results in an error.

Note: You do not have to press [=/ENTER] after pressing [2nd] [DEC], [2nd] [HEX], [2nd] [OCT], or [2nd] [BIN]. Each key sequence immediately evaluates the current expression (if an expression is displayed) and converts the result to the new number base.

Functions Allowed in Nondecimal Calculations

You can perform the following operations on nondecimal numbers:

+, −, ×, ÷, y^x, STO, RCL, EXC, negation, 2's complement, and logic operations.

If you need to perform other operations on a nondecimal number, convert the number to its decimal equivalent, calculate the result, and convert the result back to the original number base.

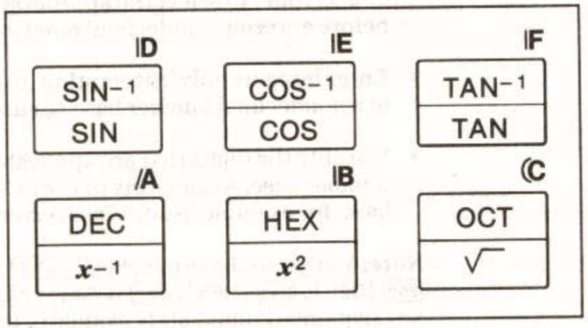
Note: When you recall the value of a variable, it is displayed in the current number base, regardless of the number base used to store the value. For example, if you store the value 16 while using the decimal base and then recall it in the hexadecimal base, it is displayed as 10 ($16_{dec} = 10_{hex}$).

Entering Hexadecimal Numbers

To make it easy to enter the hexadecimal digits A through F, the calculator reassigns the first functions of six of the keys when you select the hexadecimal number base.

Keyboard Changes for Hexadecimal Entries

In the hexadecimal number base, the hexadecimal digits A through F, instead of the marked functions, occupy the first functions of the following keys. You can enter these digits without first pressing [3rd].



The bar to the left of each hexadecimal digit is to help you distinguish them from the alphabetical symbols A–F.

The calculator displays the digits **A** through **F** in bold to help you distinguish them from the variable names A through F.

Converting Between Number Bases

You can convert a number from one number base to another. If the converted number is outside the number range for the new number base, an error condition occurs.

Base Conversions

Results are displayed in the currently selected base. By selecting a different number base while a result is displayed, you can convert the result to another base.

Example

Convert 16000_{dec} to its hexadecimal equivalent and then restore it to a decimal number.

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	—
Select decimal base.	[2nd] [DEC]	—
Enter 16000_{dec}.	16000	16000
Perform conversion.	[2nd] [HEX]	HEX 3E80
Restore decimal base.	[2nd] [DEC]	16000

Examples: Number-Base Calculations

These examples show math calculations and conversions between number bases. The last example on page 9-7 demonstrates how you can perform calculations with mixed number bases.

Hexadecimal

Display $FE4B_{hex} \div 80_{hex}$ as a decimal value.

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	—
Select HEX base.	[2nd] [HEX]	HEX —
Enter expression.	FE4B [÷] 80	HEX FE4B÷80
Evaluate and convert to decimal.	[2nd] [DEC]	508

Octal

Evaluate $47_{oct} - 377_{oct}$. Use 2's complement to change the result to a positive number, and then convert it to decimal.

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	—
Select octal base.	[2nd] [OCT]	OCT —
Enter expression.	47 [−] 377	OCT 47−377
Evaluate.	[=/ENTER]	OCT 7777777450
Change sign.	[3rd] [2's] [2nd] [ANS] [=/ENTER]	OCT 330
Convert to decimal	[2nd] [DEC]	216

Binary

Calculate $11111100_{bin} + 00001110_{bin}$, and then convert the result to decimal.

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	—
Select binary base.	[2nd] [BIN]	BIN —
Enter expression.	11111100 [+] 1110	← BIN 111100+1110
Evaluate.	[=/ENTER]	BIN 100001010
Convert to decimal.	[2nd] [DEC]	266

Mixed

In the ASCII character set, all the lowercase letters of the alphabet have values that are 32_{hex} greater than their uppercase counterparts. If the letter "Z" has a value of 113_{oct}, find the decimal value of "z."

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	—
Convert 32_{hex} offset to octal.	[2nd] [HEX] 32 [2nd] [OCT]	OCT 62
Find decimal value of letter "z."	[+] 113 [2nd] [DEC]	125

Logic Operations

You can perform logical AND, OR, XOR, and NOT operations on integer numbers in any of the calculator's number bases.

Available Logic Operators

Most of these operators compare the corresponding bits of the binary equivalents of two values. NOT is an exception; it reverses the bits of a single value. All results are integers and are displayed in the current number base.

Operator	Effect on each bit of the result		
AND	0 AND 0 = 0	0 AND 1 = 0	1 AND 1 = 1
OR	0 OR 0 = 0	0 OR 1 = 1	1 OR 1 = 1
XOR	0 XOR 0 = 0	0 XOR 1 = 1	1 XOR 1 = 0
NOT	NOT 0 = 1	NOT 1 = 0	

For example, 3_{dec} OR $5_{dec} = 7_{dec}$:

$$\begin{array}{lll} & 3_{dec} & (0\,0\,1\,1_{\,bin}) \\ \text{OR} & 5_{dec} & (0\,1\,0\,1_{\,bin}) \\ \hline & 7_{dec} & (0\,1\,1\,1_{\,bin}) \end{array}$$

Note: Although the calculator does not display leading zeros for integers, the logical operations treat each value as a multiple-digit binary number. (In the binary mode, for example, the logical NOT of 1 is 1111111110 because 1 is treated as 0000000001_{bin}.) Keep this in mind if you see unexpected results.

Example

Calculate $9F_{hex}$ XOR 01_{hex}. Convert the result to decimal.

Procedure	Keystrokes	Display
Clear entry line.	[CLEAR]	_
Enter $9F_{hex}$.	[2nd] [HEX] 9F	HEX 9F
XOR it with 01_{hex}.	[3rd] [XOR] 1 [=/ENTER]	HEX 9E
Convert to decimal.	[2nd] [DEC]	158

Appendix A: Reference Information

The information in this appendix may be useful as you become experienced with the calculator.

Appendix Contents

Syntax of Functions

This table lists the mathematical functions of the TI-60X in alphabetical order.

Function	Result	Key Sequence	Page
10^x	10 raised to xth power	`2nd` [10^x] x	3-3
Absolute Value: **ABS** x	Absolute value of x	`3rd` [ABS] x	3-2
Addition: $x1 + x2$	$x1$ plus $x2$	$x1$ `+` $x2$	3-2
AND: $x1$ **AND** $x2$	Logical AND of $x1$ and $x2$	$x1$ `3rd` [AND] $x2$	9-8
Combinations: n **nCr** r n = integer ≥ 0 r = integer ≥ 0	Number of combinations of n items taken r at a time	n `2nd` [nCr] r	8-12
COS x	Cosine of x	`COS` x	3-10
COS^{-1} x $-1 \leq x \leq 1$	Arccosine of x	`2nd` [COS^{-1}] x	3-10
COSH x	Hyperbolic cosine of x	`HYP` `COS` x	3-11
COSH^{-1} x $x > 1$	Hyperbolic arccosine of x	`HYP` `2nd` [COS^{-1}] x	3-11
Decimal Degrees to DMS: d ►**DMS**	Changes d from decimal degrees to degrees/minutes/seconds	d `3rd` [DD►DMS]	3-9
Decimal/Fraction Conversion: *dec*►fraction or *frac*►decimal	Converts *dec* to a fraction or *frac* to a decimal	*dec* `3rd` [F◄►D] or *frac* `3rd` [F◄►D]	3-5
DMS to Decimal Degrees: x ►**DD** x = D.MMSSs	Changes x from degrees/minutes/seconds to decimal degrees	x `2nd` [DMS►DD]	3-8
Deg. to Radians: d ►**R**	Changes d from degrees to radians	d `2nd` [D►R]	3-7
Division: $x1 \div x2$ $x2 \neq 0$	$x1$ divided by $x2$	$x1$ `÷` $x2$	3-2

Function	Result	Key Sequence	Page
e^x	e raised to x power (natural antilogarithm)	`2nd` [e^x] x	3-3
Factorial: $x!$ $0 \leq x \leq 69$ x = integer	**Factorial of** x	x `2nd` [x!]	3-2
Fraction/Decimal Conversion: *frac*►decimal or *dec*►fraction	Converts *frac* to decimal or *dec* to fraction	*frac* `3rd` [F◄►D] or *dec* `3rd` [F◄►D]	3-5
Fraction Mixed/Improper: *mixed*►improper or *improp*►mixed	Converts *mixed* to improper fraction or *improp* to mixed number	*mixed* `2nd` [d/c] or *improp* `2nd` [d/c]	3-5
LN x $x > 0$	Natural log of x	`LN` x	3-3
LOG x $x > 0$	Common log of x	`LOG` x	3-3
Multiplication: $x1 * x2$	$x1$ multiplied by $x2$	$x1$ `×` $x2$	3-2
Negation: $-x$	Negates x	`(-)` x	2-6
NOT x	1's complement of x	`2nd` [NOT] x	9-8
OR: $x1$ **OR** $x2$	Logical OR of $x1$ and $x2$	$x1$ `3rd` [OR] $x2$	9-8

(continued)

Function	Result	Key Sequence	Page
Percent: *x1*% of *x2*	*x1*/100 × *x2*	*x2* [×] *x1* [2nd] [%]	3-3
Percent Add-on: *x1* + *x2*%	*x2* percent of *x1* added to *x1*	*x1* [+] *x2* [2nd] [%]	3-3
Percent Discount: *x1* - *x2*%	*x2* percent of *x1* subtracted from *x1*	*x1* [−] *x2* [2nd] [%]	3-3
Permutations: *n* **nPr** *r* n = integer ≥ 0 r = integer ≥ 0	Number of permutations of *n* items taken *r* at a time	*n* [3rd] [nPr] *r*	8-12
Polar to Rectangular: (r,θ) **P►R**	Converts (r,θ) from polar to rectangular	[(] *r* [,] θ [)] [2nd] [P►R]	3-12
Power of Ten: 10^x	10 raised to *x*th power	[2nd] [10^x] *x*	3-3
Powers: y^x	*y* raised to *x*th power	*y* [y^x] *x*	3-2
Radians to Deg.: *x* **R►D**	Changes *x* from radians to degrees	*x* [3rd] [R►D]	3-7
Reciprocal: x^{-1}	1 divided by *x*	*x* [x^{-1}]	3-2
Rectangular to Polar: (x,y) **R►P**	Converts (x,y) from rectangular to polar	[(] *x* [,] *y* [)] [3rd] [R►P]	3-12
Root: $\sqrt[x]{y}$	*x*th root of *y*	*x* [2nd] [$\sqrt[x]{}$] *y*	3-2

Function	Result	Key Sequence	Page
SIN *x*	Sine of *x*	[SIN] *x*	3-10
$\mathbf{SIN}^{-1}$ *x* $-1 \le x \le 1$	Arcsine of *x*	[2nd] [SIN^{-1}] *x*	3-10
SINH *x*	Hyperbolic sine of *x*	[HYP] [SIN] *x*	3-11
$\mathbf{SINH}^{-1}$ *x*	Hyperbolic arcsine of *x*	[HYP] [2nd] [SIN^{-1}] *x*	3-11
Square: x^2	*x* multiplied by itself	*x* [x^2]	3-2
Square Root: $\sqrt{x}$ $x \ge 0$	Square root of *x*	[√] *x*	3-2
Subtraction: *x1*−*x2*	*x2* subtracted from *x1*	*x1* [−] *x2*	3-2
TAN *x*	Tangent of *x*	[TAN] *x*	3-10
$\mathbf{TAN}^{-1}$ *x*	Arctangent of *x*	[2nd] [TAN^{-1}] *x*	3-10
TANH *x*	Hyperbolic tangent of *x*	[HYP] [TAN] *x*	3-11
$\mathbf{TANH}^{-1}$ *x* $-1 < x < 1$	Hyperbolic arctangent of *x*	[HYP] [2nd] [TAN^{-1}] *x*	3-11
XOR: *x1* **XOR** *x2*	Logical XOR of *x1* and *x2*	*x1* [3rd] [XOR] *x2*	9-8

Calculation Error Conditions

When an error condition occurs, "Error" appears in the display. If you respond by pressing [CLEAR], the error condition is cleared without identifying the error. If you respond by pressing [2nd] [EQU], the calculator usually can show where the error is in your expression.

General Calculation Errors

An error condition occurs if you attempt to:

- Calculate a result (including those of memory operations) outside the range of the currently selected number base.

Decimal:	$-9.999999499 \times 10^{99}$ to -1×10^{-99}, 0 to $9.999999499 \times 10^{99}$
Hexadecimal:	FDABF41C01 to FFFFFFFFFF, 0 to 2540BE3FF
Octal:	4000000001 to 7777777777, 0 to 3777777777
Binary:	1000000001 to 1111111111, 0 to 111111111

- Divide a number by zero.
- Calculate a logarithm or reciprocal of zero.
- Calculate zero to the 0th power or root, or to a negative power or root.
- Calculate the tangent of 90° or 270°, $\pi/2$ radians or $3\pi/2$ radians, or their rotational multiples such as 450°.
- Calculate permutations near the peak (r = n −1 or r = n) for a set size n when n exceeds 69, or when n or r is not a positive integer. The interval near the peak that exceeds the calculator's range expands as n increases above 69.
- Calculate combinations near the peak (r = n/2) for a set size n when n exceeds 336, or when n or r is not a positive integer. The interval near the peak that exceeds the calculator's range expands as n increases above 336.

General Calculation Errors (Continued)

- Generate more than four pending operations or an unmatched close parenthesis.
- Use a real number as the input for polar/rectangular conversions.
- Begin the simultaneous equations routine with a nondecimal number base selected.
- Enter a data point into the statistical registers with a nondecimal number base selected.
- Calculate a function using a value outside the valid input ranges listed for that function. (See the table on page A-10.)
- Calculate an inverse trigonometric function whose result is outside the valid range for that function. (See the table on page A-11.)

Statistical Calculation Errors

The error conditions listed in this section occur only when working with a statistics data set. These errors occur when you attempt to do the following.

- Enter a one-variable data point when a two-variable data point is already entered.
- Enter a two-variable data point when a one-variable data point is already entered.
- Enter a data point while a nondecimal number base is selected.
- Enter a frequency that has a leading zero.
- Remove the only data point in the registers.
- Calculate a statistics result when there is no entered statistics data set.
- Calculate sample standard deviation, slope, intercept, correlation, x′, or y′ with just one data point entered.
- Calculate slope, intercept, correlation, x′, or y′ of a data set that consists of repeat occurrences of all the same point.
- Calculate slope, intercept, correlation, x′, or y′ of a vertical line, or when one-variable statistics are selected.
- Calculate the correlation or x′ of a horizontal line.

Entry-Line Error Conditions

Mistakes in the entry line that are not calculation related also can cause the "ERROR" message to be displayed. As with calculation errors, you can press [CLEAR] or [2nd] [EQU]. [2nd] [EQU] re-displays the expression with the cursor positioned near the likely cause of the error.

Number Entry Errors

An entered number that contains any of the following mistakes causes an error condition.

- An extra decimal point
- Misplaced negation
- Invalid exponent of scientific notation: a character other than negation or 0 through 9 is present
- Too many digits in a number
- Inappropriate characters for a decimal number: more than 10 digits in a number, an extra comma in a coordinate pair or two-variable statistical entry
- Inappropriate characters for a nondecimal number: scientific notation, a decimal point

Syntax Errors

Syntax mistakes in the entry line also cause an error.

- Mismatched close parenthesis
- Adjacent symbols that do not belong together
- A function that belongs before its argument but occurs after it
- A function that belongs after its argument but occurs before it
- Using an undefined variable in an equation
- Following a memory-math operation key with something other than a defined variable name

Function Ranges

An error results if you perform a calculation outside the range of certain functions. The following tables give the ranges of inputs for functions, and ranges of results for the inverse trigonometric functions and for angle conversion to DMS format.

Input Ranges

Function	Input Range
SIN x, COS x, TAN x,	$\lvert x\rvert < 1E14°$ or $\lvert x\rvert < 1.745329252E12$ radians
SIN^{-1} x, COS^{-1} x	$\lvert x\rvert \le 1$
TAN^{-1} x	range of the calculator
SINH x, COSH x	$\lvert x\rvert \le 230.2585092$
TANH x	$\lvert x\rvert < 5E99$
$SINH^{-1}$ x	$\lvert x\rvert < 5E99$
$COSH^{-1}$ x	$1 \le x < 5E99$
$TANH^{-1}$ x	$\lvert x\rvert < 1$
1/x	range of the calculator (0 is invalid)
LN x, LOG x, $\sqrt{x}$	positive range of the calculator (0 invalid for LN and LOG)
e^x	negative range of the calculator and $x < 230.2585092$
10^x	negative range of the calculator and $x \le 99.99999997$
x!	$0 \le x \le 69$ where x is an integer
universal powers of negative numbers	power must be integer or the reciprocal of an odd number
universal roots of negative numbers	root must be an odd number

Result Ranges

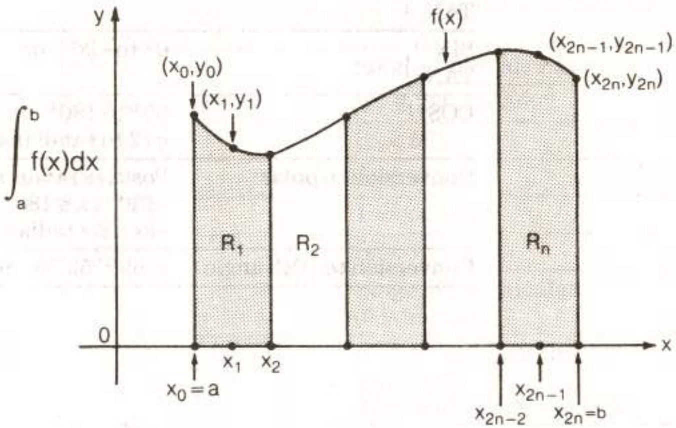
Function	Range of Resulting Angle
SIN^{-1}, COS^{-1}, TAN^{-1}	0° to 90° or $\pi\div2$ radians
SIN^{-1}, TAN^{-1}	0° to −90° or $-\pi\div2$ radians
COS^{-1}	90° to 180° or $\pi\div2$ to π radians
Conversion to polar	Positive radius at $-180° < x \le 180°$ or $-\pi < x \le \pi$ radians
Conversion to DMS angle	≤999°59′59.99″

Simpson's Rule

The TI-60X uses Simpson's rule to find the integral of a function. This section discusses the method in detail. The procedure for integrating is described in Chapter 6.

How the Calculator Integrates

During integration, the TI-60X evaluates your function at several sample points and uses Simpson's rule for determining the area of each interval.



The area is divided into two subintervals per interval, so entering n intervals yields 2n subintervals. The subinterval boundaries are at $x^0(=a)$, x^1, ..., x_{2n-1}, $x_{2n}(=b)$. The even-numbered subinterval boundaries are also interval boundaries. The odd-numbered boundaries are interval midpoints.

The area of each interval is calculated by taking a weighted average of the boundary values and midpoint $(y_0 + 4y_1 + y_2)/6$, and multiplying by the width. Because the midpoint is more representative of the interval height than a boundary, it has the greatest weighting (4/6). Each boundary has a lesser weighting (1/6) because the boundary may be deceptively high or low. The width of each subinterval is $h = (b - a) \div 2n$, making the width of each interval 2h.

How the Calculator Integrates (continued)

Simpson's approximation for the area of the first interval is $A_1 = (y_0 + 4y_1 + y_2)/6 \times 2h$, which is simplified as $A_1 = h/3 \times (y_0 + 4y_1 + y_2)$.

The combined areas of the intervals $A_1 + A_2 + \ldots + A_n$ results in the area under the curve. In calculating the area of each interval, this method multiplies by h/3, which can be factored out when combining areas. After combining the sums of boundaries and midpoints, Simpson's rule is stated as:

$$\int_a^b f(x)dx =$$

$$h/3 \times (y_0 + 4y_1 + 2y_2 + 4y_3 + \ldots + 2y_{2n-2} + 4y_{2n-1} + y_{2n})$$

Even terms (except for the first and last) have a weighting of 2 because they apply to both intervals that are adjacent to that boundary. The first and last terms have a weighting of 1 because they are unshared boundaries. Odd terms have a weighting of 4 because they are interval midpoints.

Memory Messages

If you attempt an operation that requires more memory than is available, the TI-60X displays one of two messages: CLR XX REGS, or REGS IN USE. For information on what to clear and how to clear it, Refer to Chapter 4: Memory and Variables.

The CLR XX REGISTERS Message

The following operations require a specific amount of memory and may display the **CLR XX REGS** message (where XX is the number of memory registers you must clear).

- Pressing [2nd] [SIMUL] with any variable or formula defined
- Pressing [Σ+] to enter two-variable statistical data when available memory is less than two registers
- Attempting to integrate a formula with insufficient registers available

Registers in Use

The following operations may display the **REGS IN USE** message.

- Pressing [2nd] [SIMUL] or attempting to integrate a formula with data in the statistical registers
- Pressing [2nd] [FMLA] or attempting to define a variable with an insufficient number of registers available.
- Attempting to evaluate an expression with more than two pending operations when the statistical registers contain data.
- Attempting to store a variable when no registers are available.
- Attempting to solve a formula with no register available for the result variable.

Appendix B: Service Information

Appendix Contents

Battery Information

The TI-60X uses a lithium manganese battery for about 1,500 hours of operation. You must replace the old battery with Union Carbide (Eveready) CR2032, Duracell DL2032, or the equivalent.

When to Replace the Battery

As a battery runs down, the display begins to dim. When you find it difficult to read the display under normal viewing conditions, the remaining battery life may be only about one week.

Effects of Replacing the Battery

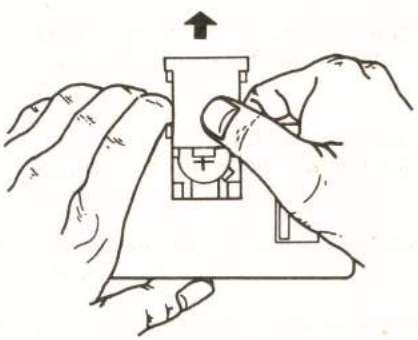
The calculator cannot hold data in its memory when the battery is removed or becomes discharged. Replacing the battery has the same effects as pressing [3rd] [RESET] [YES].

Replacing the Battery

To replace the battery, follow these steps:

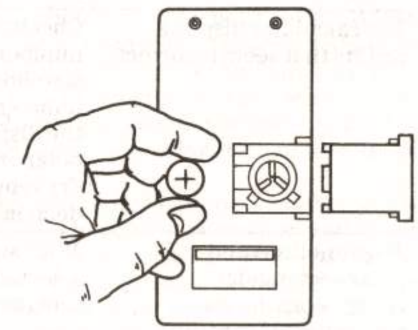
1. Turn the calculator off and turn it over so that the back is facing you.

2. Placing your thumb on the battery cover, press and slide until the cover slides off the back of the calculator.

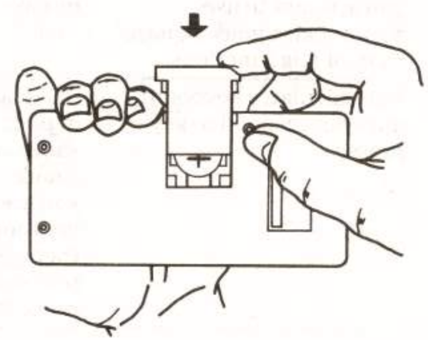


Replacing the Battery (Continued)

3. Remove the discharged battery and install a new one as shown. Be sure that the + symbol is facing up (toward the back of the calculator).



4. Insert the cover into the grooves, pressing gently on the battery, and slide the cover back into place.



When you turn the calculator on, the display shows **CLEARED**, and the calculator is ready for use.

Caution: Dispose of an old battery properly. Do not incinerate a battery or leave it where a child can find it.

In Case of Difficulty

If you have difficulty operating the calculator, you may be able to correct the problem without returning the calculator for service. The following table lists several problems and their possible solutions. If these solutions do not correct the problem, refer to "Service Information" on page B-6.

Possible Solutions

Difficulty	Solution
An error occurs.	Check the error conditions listed in Appendix A.
The calculator displays results that seem incorrect.	Check for a nondecimal number-base indicator. Try scrolling to part of the number that may be past the display, especially in a polar or rectangular result. Try removing any fixed decimal setting.
Trig functions and polar/rectangular conversions do not give the correct results.	Make sure you have selected the correct angle unit (degrees or radians).
The calculator displays hexadecimal digits when you attempt to use reciprocal, square, square root, or trig functions.	Make sure the calculator is not set to the hexadecimal number base.
The calculator keyboard does not respond to key presses.	If a lengthy integration is in progress, the display may show the message CALC for a noticeable duration. If you are not integrating, try pressing [2nd] [OFF] and then [ON]. You can also try removing the battery and reinserting it.

You also should review the operating instructions in this guidebook to be sure that you are performing the calculations correctly.

Suggestions from Customers

If you want to make any suggestions concerning specific calculator applications, please follow the instructions below.

Suggestions from Customers

Because of the number of suggestions that 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 key sequence that you have developed, please include the following statement with your suggestions:

"All of the information forwarded herewith is presented to Texas Instruments on a nonconfidential, nonobligatory basis; no relationship, confidential or otherwise, expressed or implied, is established with Texas Instruments by this presentation. Texas Instruments may use, copyright, distribute, publish, reproduce, or dispose of the information in any way without compensation to me."

You may write to the following address:

Texas Instruments Incorporated
Consumer Relations
P.O. Box 53
Lubbock, Texas 79408-0053

If the solutions suggested by "In Case of Difficulty" do not correct a problem you may have with your calculator, please call or write Consumer Relations to discuss the problem.

For Service and General Information

If you have questions about service or the general use of your calculator, please call Consumer Relations toll-free at:

1–800–TI CARES (1–800–842–2737)

You may also write to the following address:

Texas Instruments Incorporated
Consumer Relations
P.O. Box 53
Lubbock, Texas 79408–0053

Please contact Consumer Relations:

- Before returning the calculator for service
- For general information about using the calculator

For Technical Information

If you have technical questions about calculator operation or programming applications, write to Consumer Relations at the address given above, or call 1–806–741–2663. Please note that this is a toll number, and collect calls are not accepted.

Express Service

Texas Instruments offers an express service option for fast return delivery. Please call Consumer Relations for information.

Returning Your Calculator for Service

A defective calculator will be either repaired or replaced with the same or comparable reconditioned model (at TI's option) when it is returned, postage prepaid, to a Texas Instruments Service Facility.

Texas Instruments cannot assume responsibility for loss or damage during incoming shipment. For your protection, carefully package the calculator for shipment and insure it with the carrier. Be sure to enclose the following items with your calculator:

- Your full return address and daytime phone number
- Any accessories related to the problem
- A note describing the problem you experienced
- A copy of your sales receipt or other proof of purchase to determine warranty status

Please ship the calculator postage prepaid; COD shipments cannot be accepted.

In-Warranty Service

For a calculator covered under the warranty period, no charge is made for service.

Out-of-Warranty Service

A flat-rate charge by model is made for out-of-warranty service. To obtain the service charge for a particular model, call Consumer Relations **before** returning the product for service. (We cannot hold products in the Service Facility while providing charge information.)

Texas Instruments Service Facilities

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Texas Instruments
41 Shelley Road
Richmond Hill, Ontario L4C 5G4

One-Year Limited Warranty

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

Warranty Duration — This calculator is warranted to the original consumer purchaser for a period of one (1) year from the original purchase date.

Warranty Coverage — This calculator is warranted against defective materials or workmanship. **This warranty is void if the product has been damaged by accident, unreasonable use, neglect, improper service, or other causes not arising out of defects in material or workmanship.**

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-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 consumer or any other user.**

Some states do not allow the exclusion or limitations of implied warranties or consequential damages, so the above limitations or exclusions may not apply to you.

Legal Remedies — This warranty gives you specific legal rights, and you may also have other rights that vary from state to state.

Warranty Performance — During the above one-year warranty period, a defective TI calculator will either be repaired or replaced with a reconditioned comparable model (at TI's option) when the product is returned, postage prepaid, to a Texas Instruments Service Facility.

The repaired or replacement calculator will be in warranty for the remainder of the original warranty period or for six months, whichever is longer. Other than the postage requirement, no charge will be made for such repair or replacement.

Texas Instruments strongly recommends that you insure the product for value prior to mailing.

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