Chapter 2: Math Operations

The TI-95 mathematics capabilities include a variety of functions that exceeds that of most scientific calculators.

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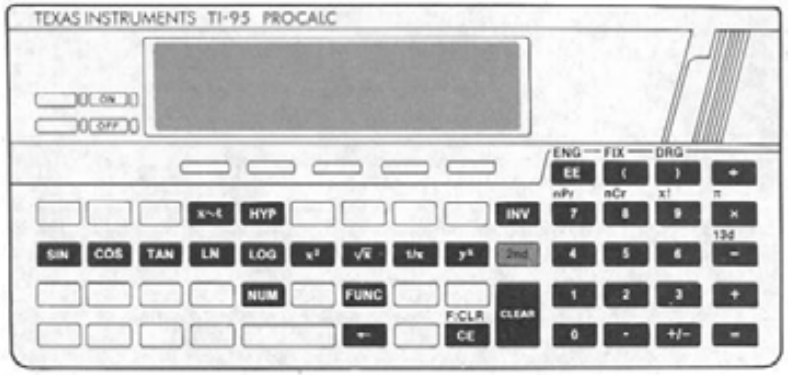
Location of the Math Keys

The keys used to perform math operations are shown in the figure below. You should familiarize yourself with these keys and their location on the keyboard.



AOS™ Algebraic Operating System

The AOS™ Algebraic Operating System enables you to enter numbers and combined operations into the calculator in a straightforward sequence. To ensure your calculations are performed in the correct order, the AOS uses algebraic rules to assign priorities to the mathematics operations.

Purpose

Without a fixed set of algebraic rules, a problem such as $16-8\div2+6$ may have several possible answers, depending on the order in which the operations are completed. However, the Algebraic Operating System solves this problem by completing the division first $(8\div2)$ and then completing the subtraction and addition. Therefore, $16-8\div2+6=18$.

Pending Operations

In a problem such as $4\times5=20$, simply entering 4 [×] 5 does not produce the answer. The operation must be completed by pressing an appropriate key such as [=]. (Note that multiplication can be completed by any operation that has equal or lower priority in the algebraic hierarchy.) Until completed, 4×5 creates a pending operation.

The TI-95 can perform calculations containing a maximum of eight pending operations.

Note: Immediate functions, such as x^2, complete themselves and do not need to be completed by pressing another key.

(continued)

Algebraic Hierarchy

The AOS algebraic hierarchy completes all operations according to their relative priorities, which are listed below in descending priority.

1. Immediate functions—[SIN], [COS], [TAN]
   [INV] [SIN], [INV] [COS], [INV] [TAN]
   [HYP] [SIN], [HYP] [COS], [HYP] [TAN]
   [INV] [HYP] [SIN], [INV] [HYP] [COS], [INV] [HYP] [TAN]
   [2nd] [nPr], [2nd] [nCr], [2nd] [x!]
   [LOG], [INV] [LOG], [LN], [INV] [LN]
   [CONV] functions, [NUM] functions
   [x^2], [$\sqrt{x}$], [1/x]
2. Universal powers and roots—[y^x], [INV] [y^x]
3. Multiplication and division—[×], [÷]
4. Addition and subtraction—[+], [−]
5. Equals—[=]

With the AOS hierarchy, lower-priority operations are delayed until higher-priority operations are complete.

- Operations in priority 1 are immediate functions. These functions are performed as soon as you press the keys.
- Operations in priorities 2, 3, and 4 are completed by any operation with the same or a lower priority. For example, multiplication and division are completed by another [×] or [÷] operation or by [+], [−], or [=].
- The [=] key completes all operations. If you finish a calculation with the [=], there is no need to clear the calculator prior to performing another calculation.

Example

The following calculation illustrates the algebraic hierarchy and pending operations.

Calculate $4+8\div2^5-2$.

Procedure	Press	Display
Clear display	[CLEAR]	0.
Enter addition	4 [+]	4. +
Enter pending division (addition is also pending)	8 [÷]	8. /
Enter pending power (addition and division are also pending)	2 [y^x]	2. y^x
Complete pending operations and set up pending subtraction	5 [−]	4.25 −
Complete calculation	2 [=]	2.25

Because subtraction is lower than division and equal to addition in the AOS hierarchy, both of these operations are completed.

Using Parentheses to Override AOS

At times, you may want an expression evaluated differently from the normal order of evaluation. Using parentheses lets you control the order of evaluation. You should use parentheses if you have any doubts about the way the calculator will evaluate an expression.

Effect of Parentheses

Using parentheses enables you to give priority to operations within an expression. When you enclose a portion of an expression within parentheses, that portion is evaluated separately.

Although some mathematics expressions often use parentheses to imply multiplication, the TI-95 requires that you include the [×] key in the calculation. For example, you must enter $7(3+5)$ as $7\times(3+5)$.

Example Calculate $7\times(3+5)$.

Procedure	Press	Display
Clear display	CLEAR	0.
Begin pending multiplication	7 ×	7.
Enter and evaluate parenthetical expression	(3 + 5)	8.
Complete pending operation	=	56.

If this expression were entered without parentheses, the AOS feature would complete the multiplication (7×3) before the addition ($+5$), producing an incorrect result of 26.

Levels of Parentheses

You can use up to 15 levels of parentheses. This gives you the capability to enter more complex expressions.

Example Calculate $2\times(2\times(2\times(2\times(2+3)+2)+2)))$.

Procedure	Press	Display
Clear display	CLEAR	0.
Enter pending multiplications	2 × (2 × (2 × (2 × (2 ×	2.
Enter $(2+3)$	(2 + 3)	5.
Evaluate $(2\times5+2)$	+ 2)	12.
Evaluate $(2\times12+2)$	+ 2)	26.
Evaluate (2×26)	)	52.
Evaluate (2×52)	)	104.
Evaluate 2×104	=	208.

It is not necessary to press [)] when it is at the end of a calculation. Pressing [=] automatically closes all open parentheses, evaluates the expression in the proper order, and displays the end result. However, if you want to see the intermediate result of a parenthetical expression, you must use the [)] key.

Entering Data

The data entry keys enable you to enter the numerical data needed to perform calculations. You can enter numbers in either standard or scientific notation.

Entering Digits

The digit keys enter numbers into the display. In standard notation, you can enter up to 13 digits and a decimal point. In scientific notation, you can enter 13 digits, a decimal point, and two exponent digits.

Entering the Decimal Point

The [.] key enters a decimal point. Only one decimal point can be entered. The exponent of scientific notation cannot include a decimal point.

Changing the Sign

The [+/−] key changes the sign of the number in the display. This enables you to enter negative numbers and negative exponents. To enter a negative number, press the [+/−] key before, during, or after entering the number. To enter a negative exponent, press the [+/−] key after entering the exponent.

Correcting Entries

The [←] key enables you to backspace the number in the display to replace a digit. After you replace the digit, you can continue entering data.

Entering Scientific Notation

The [EE] key enables you to enter numbers in scientific notation. You can enter numbers as small as $\pm 1 \times 10^{-99}$ or as large as $\pm 9.999999999999 \times 10^{99}$.

Note: If the result of a calculation is outside the range −9999999999 to −.000000001, zero, or .000000001 to 9999999999, the calculator displays the number in scientific notation even though you have not pressed [EE].

Entering Pi

The [2nd] [π] key sequence enters the value of pi to 13 significant digits, with a value of 3.141592653590. The display shows the value of pi rounded to ten digits, 3.141592654, unless you have selected a format other than the standard, 10-digit display.

Clearing the Calculator

The calculator contains several keys used for clearing. When you use one of the clear keys on the calculator, you should be sure that you will not affect areas you do not want to clear.

The [CLEAR] Key

When you press the [CLEAR] key, the alphanumeric area of the display is cleared. The standard display format is returned. Also, any fields in progress and any pending operations in the AOS stack are cleared.

The [CE] Key

When you press the [CE] key, the entry you just made is cleared if no other function key has been pressed. The AOS stack is not affected. This enables you to continue with a calculation without starting over.

The [2nd] [CMS] Key Sequence

When you press [2nd] [CMS], the data registers, as defined by the current partition, are cleared.

The [2nd] [CP] Key Sequence

When you press [2nd] [CP] in the learn mode, programs you have stored in program memory are cleared.

The [2nd] [F:CLR] Key Sequence

When you press [2nd] [F:CLR], the function-key label area of the display is cleared.

The RESET Button

You should only press the RESET button as a "last resort" to restart the calculator when a problem occurs that prevents you from entering from the keyboard. The button is flush with the case of the calculator so that you cannot press it accidentally. When you press the RESET button, the display is cleared and replaced with the message **MEM MAY BE LOST.** The following conditions are changed. For other effects, refer to "System Parameter Settings" in Appendix A.

- The display format is changed to standard notation.
- The decimal point is changed to floating decimal.
- The number base is changed to decimal.
- The temporary register is cleared.

You may occasionally enter an incorrect number or press an incorrect function key. You can use the CLEAR key to remove these errors, but this also clears the display, cancels all operations, and clears scientific notation. In many instances, you can correct an error without these unwanted effects.

Correcting Numeric Entries

You can correct mistaken numeric entries using the ← or the CE key, provided you have not yet pressed an operation key such as + or =.

- When you use the ← key, the display is backspaced one character at a time to enable you to replace any digit or decimal point in the mantissa. You can also use this key to correct the exponent if you are entering in scientific notation.
- When you use the CE key, the entire number entry is cleared but pending operations are not.

If you make an error while entering the mantissa of a number in scientific notation, you must correct the error before pressing the EE key. After you have pressed the EE key, you can make corrections to the exponent using the ← key or by entering new numbers over the incorrect numbers. The CE key cannot be used to correct only the exponent.

Correcting Pending Operations

You may be able to correct another type of mistaken entry, depending on whether the entry completes a pending operation.

- If the incorrect entry has an equal or higher priority than the intended entry, you can immediately press the correct key and continue. The calculator will obtain the correct result.
- If the incorrect entry has a lower priority than the intended entry, it may complete a pending operation. Even if you replace the incorrect entry, the calculator will obtain an incorrect result.

The examples on the next page illustrate when you can correct mistaken entries involving a pending operation.

Equal Priority Example

Calculate $10.6 + 12.7 \times 5$.

Procedure	Press	Display
Clear display	CLEAR	0.
Enter addition	10.6 +	10.6 +
Incorrect ÷ does not complete pending +	12.7 +	12.7 /
Correct × replaces ÷, yields correct answer	× 5 =	74.1

Lower Priority Example

Calculate $10.6 + 12.7 \times 5$.

Procedure	Press	Display
Clear display	CLEAR	0.
Enter addition	10.6 +	10.6 +
Incorrect minus completes pending +	12.7 −	23.3 −
Correct × yields incorrect answer	× 5 =	116.5

Selecting the Format of Displayed Values

Although all numeric values are stored in the calculator with a 13-digit mantissa, you can choose the format in which the calculator displays these values. Three formats are available. You can also fix the number of decimal places or display the entire 13 digits.

Standard

The calculator is in standard notation when you turn it on until you select another notation. In this format, a number is displayed with a maximum of ten digits and a decimal. A sign is also displayed if the number is negative. The following list shows the ranges of values that can be displayed in standard notation.

$-9999999999.$ to -0.000000001
zero
0.000000001 to $9999999999.$

Values outside these ranges are automatically converted to scientific notation. When values are once again in range, they are displayed in standard notation.

Scientific Notation

To convert to the scientific notation format, press EE. Numbers are displayed as a 7-digit mantissa with a 2-digit exponent. Because pressing EE puts the calculator in the live entry mode, the mantissa may have more than 7 digits when you first press EE. The internal value is displayed until you make your first entry. All numbers are displayed in this notation until you select a different format.

Press INV EE to return the calculator to standard notation. If you have selected a fixed number of decimal positions, this is not changed.

Engineering Notation

To convert to the engineering notation format, press 2nd [ENG]. This is a form of scientific notation with an exponent that is a multiple of three. This enables the display of engineering-related results, such as 10^6 for megohms or 10^{-12} for picofarads.

All numbers are displayed in this notation until you select standard notation. (You cannot convert directly from engineering to scientific notation.)

Press INV 2nd [ENG] to return the calculator to standard notation. If you have selected a fixed number of decimal positions, this is not changed.

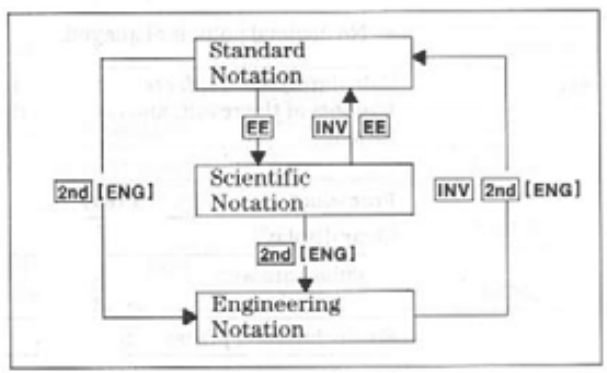
Example

The following example illustrates the conversion of numbers from one notation to another.

Procedure	Press	Display
Clear display	CLEAR	0.
Enter number in standard notation	740772592.9 +/–	– 740772592.9
Convert to scientific notation	EE =	– 7.407726 08
Convert to standard notation	INV EE	– 740772592.9
Convert to engineering notation	2nd [ENG]	– 740.7726 06
Convert to standard notation	INV 2nd [ENG]	– 740772592.9

Summary of Notation Conversions

The key sequences required to convert between display notations are summarized in the illustration below.



(continued)

Selecting the Format of Displayed Values (Continued)

In addition to selecting the notation of the displayed value (standard, scientific, or engineering), you can set the number of decimal places to be displayed. You can also display the entire 13 digits in a number, regardless of the format selected.

Fixing the Number of Decimal Places

The calculator normally displays numbers with a floating decimal point. You can, however, display results with a fixed number of decimal places.

The key sequence [2nd] [FIX], followed by any number from 0 to 8, fixes the number of decimal places. Displayed numbers are rounded as necessary to the number of decimal places you select. Only the display is affected. The number is not changed internally.

[2nd] [FIX] 9 restores the floating decimal point.

Displaying All 13 Digits

The [2nd] [13d] key sequence lets you examine the digits not normally shown in the display due to rounding.

When you use this function, all 13 digits in the numeric display register are displayed.

- They are preceded by the sign of the number.
- No exponent is displayed, regardless of notation.
- The 13-digit display is temporary.
- No decimal point is displayed.

Example

Calculate 3.9 ÷ .41, fix to four decimal places, display all 13 digits of the result, and return to floating-decimal format.

Procedure	Press	Display
Clear display	[CLEAR]	0.
Calculate answer	3.9 [÷] .41 [=]	9.512195122
Fix decimal to 4 places	[2nd] [FIX] 4	9.5122
Examine all 13 digits	[2nd] [13d]	+9.512195121951
Clear fixed decimal	[2nd] [FIX] 9	9.512195122

Entering Numbers in Scientific Notation

You can enter numbers in scientific notation regardless of which display format you have selected.

Procedure

To enter numbers in scientific notation:

1. Enter the mantissa, including [+/–] if negative.
2. Press [EE].
3. Enter the exponent, including [+/–] if negative.

When you press an operation key, the display and resulting notation depend on prior conditions.

- If you have previously selected standard or scientific notation, the number is displayed in the scientific format and the calculator remains in scientific notation until changed.
- If you have previously selected engineering notation, the number is normalized to the engineering format and the calculator remains in engineering notation until changed.

Example

Enter the number -74.07×10^4 when the calculator is in the standard display format.

Procedure	Press	Display
Clear display	[CLEAR]	0.
Enter the mantissa	74.07 [+/–]	–74.07
Enter the exponent	[EE] 4	–74.07 04
Convert to scientific notation	[=]	–7.407 05
Return to standard notation	[INV] [EE]	–740700.

Arithmetic Operations

The four basic arithmetic operations—addition, subtraction, multiplication, and division—are the mathematical functions you will use most often when solving problems with your calculator.

Basic Arithmetic Keys

The [+], [−], [×], and [÷] keys perform the four basic arithmetic functions. When you use a combination of these functions in an expression, the AOS™ system keeps track of the priorities and causes the functions to be performed in the correct order.

The [=] key completes all pending operations and displays the result of a calculation.

Example

Calculate $15+(6\div3)\times4$.

Procedure	Press	Display
Clear display	CLEAR	0.
Enter addition	15 +	15. +
Enter division (pending addition not completed)	6 ÷ 3	3
Complete division (6 ÷ 3)	×	2. *
Calculate 15 + (2 × 4)	4 =	23.

Reciprocals, Squares, and Square Roots

The reciprocal (x^{-1}), square (x^2), and square root ($x^{.5}$) can be considered mathematically as raising a number to a predetermined power. Your calculator performs these functions in one keystroke. The functions are performed immediately and do not affect any pending operations.

Reciprocals

Use the [1/x] key to calculate the reciprocal of any nonzero number in the display.

Squares

Use the [x²] key to calculate the square of a number in the display if the result is within the range of the calculator.

Square Roots

Use the [√x] key to determine the square root of a positive number in the display.

Example

This example illustrates the operation of the [1/x], [x²], and [√x] functions.

Procedure	Press	Display
Clear display	CLEAR	0.
Enter a negative number	8 +/−	−8
Calculate the reciprocal of the number	1/x	−0.125
Calculate the square of the displayed number	x²	0.015625
Calculate the square root of the displayed number	√x	0.125
Change displayed number to a negative value	+/−	−0.125
Display indicates a negative number has no real square root	√x	INVALID ARGUMENT
Clear error condition	CLEAR	0.

Universal Powers and Roots

The universal power and universal root functions calculate any power or root value of a positive number. They will also calculate integer powers of negative numbers. Both functions are pending operations that must be completed by entering an operation key.

Universal Powers

You can use the universal power key [y^x] to raise a positive number to any power. You can also raise a negative number to an integer power. The power can be either negative or positive.

To use the universal power function:

1. Enter the number (the y value) you want raised to a power.
2. Press [y^x].
3. Enter the power (the x value).
4. Press any operation key to complete the calculation.

Example Calculate $3.1^{4.7}$ and -3.1^4

Procedure	Press	Display
Clear display	CLEAR	0.
Enter positive y value	3.1 y^x	3.1 y^x
Enter x value	4.7	4.7
Complete the pending operation	=	203.8918944
Enter negative y value	3.1 +/− y^x	−3.1 y^x
Enter integer x value	4	4
Complete the pending operation	=	92.3521

Universal Roots

You can use the universal root function [INV] [y^x] to determine any root (positive or negative) of a positive number. You can also determine a root of a negative number if the reciprocal of the root is an integer.

To use the universal root function:

1. Enter the number (the y value) and press [INV] [y^x].
2. Enter the root (the x value) and press an operation key.

Example Calculate $\sqrt[-3.8]{21}$ and $\sqrt[.5]{21}$.

Procedure	Press	Display
Clear display	CLEAR	0.
Enter positive y value	21 INV y^x	21. x^y
Enter negative x value	3.8 +/−	−3.8
Complete the operation	=	0.448794529
Enter negative y value	21 +/− INV y^x	−21. x^y
Enter x value	0.5	.5
Complete the operation	=	441.

Trigonometric Operations

You can use the calculator to perform operations involving the most commonly used trigonometric functions and set it to display the results in either degrees, radians, or grads.

Selecting the Angle Units

When you turn the calculator on, you can enter angles in the angle units last selected. The results of any angle calculations are also displayed in these angle units.

The key sequence 2nd [DRG] changes the angle units. Each time you press this key sequence, the calculator rotates to the next unit. The rotation sequence is degrees, radians, grads, and then degrees again. You can press INV 2nd [DRG] at any time and return to degree units. A status indicator in the display shows the units you have selected.

Changing the angle units does not convert a number in the display. You can use angle conversions, described on page 4–8, to convert a number in the display without changing angle modes.

Available Trigonometric Functions

The following table lists the trigonometric functions available on the calculator and the keys you must press to obtain them. All are immediate functions.

Trigonometric Function	Keys
Sine	SIN
Cosine	COS
Tangent	TAN
Arcsine	INV SIN
Arccosine	INV COS
Arctangent	INV TAN

Example

In the following example, calculate the cosine of 35° and the arccosine of the result to illustrate the operation of the trigonometric functions.

Procedure	Press	Display
Clear display	CLEAR	0.
Select degree mode	INV 2nd [DRG]	DEG MODE
Enter the number	35	35
Calculate the cosine	COS	.8191520443
Calculate the arccosine	INV COS	35.

Hyperbolic Operations

Hyperbolic operations have properties that are very similar to the trigonometric operations described previously. However, the angle units setting does not affect the results of a hyperbolic function because these functions are not based on angles.

The Hyperbolic Key

The [HYP] key enables you to use the trigonometric keys on your calculator to perform hyperbolic functions. The [INV] key enables you to perform the inverse hyperbolic functions.

The following table lists the hyperbolic functions available on your calculator and the key sequences you use to obtain them. Note that the [INV] and [HYP] keys may be pressed in either order when calculating the inverse hyperbolic functions.

Hyperbolic Function	Keys
Hyperbolic sine	[HYP] [SIN]
Inverse hyperbolic sine	[INV] [HYP] [SIN] or [HYP] [INV] [SIN]
Hyperbolic cosine	[HYP] [COS]
Inverse hyperbolic cosine	[INV] [HYP] [COS] or [HYP] [INV] [COS]
Hyperbolic tangent	[HYP] [TAN]
Inverse hyperbolic tangent	[INV] [HYP] [TAN] or [HYP] [INV] [TAN]

Example

The following example illustrates the operation of the hyperbolic functions.

Procedure	Press	Display
Clear display	[CLEAR]	0.
Enter a number	3	3
Calculate the hyperbolic sine	[HYP] [SIN]	10.01787493
Enter a number	.5	.5
Calculate the inverse hyperbolic tangent	[INV] [HYP] [TAN]	.5493061443

Factorials, Permutations, and Combinations

In probability calculations, you often need to multiply a series of consecutive numbers (factorials) or find the number of possible arrangements of items (permutations or combinations). The functions discussed in this section provide you with these capabilities.

Factorial

The factorial function enables you to calculate the factorial of negative or positive numbers.

The range of negative numbers is from −70.5 to 0. Only half-integer numbers are valid. For example, −8.5 and −9.5 are valid inputs, but −9 is not.

The factorial of any number less than −70.5 results in an answer of 0., indicating an underflow, due to the limit of 13 digits in the mantissa.

The valid range of positive numbers is from 0 to 69.5. Both half- and whole-integer numbers are valid. For example, 8.5, 9, and 9.5 are all valid inputs.

The factorial function operates on the internal value, not the displayed value. Use the [2nd] [13d] key sequence to ensure a displayed number is a valid input.

Example

The following example illustrates the operation of the factorial function.

Procedure	Press		Display
Clear display	[CLEAR]		0.
Calculate −49.5 factorial	49.5 [+/−] [2nd] [x!]	x! =	−3.624523 −62
Calculate −49 factorial	49 [+/−] [2nd] [x!]		INVALID ENTRY
Calculate 49 factorial	[CLEAR] 49 [2nd] [x!]	x! =	6.082819 62
Calculate 9.999999999 divided by 2	9.999999999 [÷] 2 [=]		5.
Calculate the factorial	[2nd] [x!]		INVALID ENTRY
Clear display	[CLEAR]		0.

Permutations

This function enables you to calculate the number of permutations of n items taken r at a time. The range is limited only by the range of the calculator as long as n is a positive number equal to or greater than r. If your calculation exceeds the range of the calculator, an **OVERFLOW** message appears.

Example

Calculate the number of possible arrangements of six appliances of the same width on a kitchen wall with only room for three.

Procedure	Press		Display
Clear display	[CLEAR]		0.
Calculate the permutations	6 [x⇆t] 3 [2nd] [nPr]	nPr =	120.

Combinations

This function enables you to calculate the number of combinations of n items taken r at a time. The range is limited only by the range of the calculator as long as n is a positive number equal to or greater than r. If your calculation exceeds the range of the calculator, an **OVERFLOW** message appears.

Example

Calculate the number of hands you might draw from a deck of 52 cards if you draw 5 cards each time.

Procedure	Press		Display
Clear display	[CLEAR]		0.
Calculate the combinations	52 [x⇆t] 5 [2nd] [nCr]	nCr =	2598960.

Logarithms

The TI-95 can perform calculations involving common and natural logarithms and their inverses (antilogarithms).

Logarithms

The [LN] key calculates the natural (base e) logarithm of a number in the display. The [LOG] key calculates the common (base 10) logarithm of a number in the display. These functions require a positive input value.

Antilogarithms

The key sequence [INV] [LN] calculates the natural antilogarithm of a number in the display. The natural antilogarithm function can be thought of as e^x.

The key sequence [INV] [LOG] calculates the common antilogarithm of a number in the display. The common antilogarithm function can be thought of as 10^x.

Example

The following example illustrates the operation of the logarithm and antilogarithm functions.

Procedure	Press	Display
Clear display	[CLEAR]	0.
Enter a number	83	83
Calculate the common logarithm	[LOG]	1.919078092
Calculate the common antilogarithm	[INV] [LOG]	83.
Calculate the natural logarithm	[LN]	4.418840608
Calculate the natural antilogarithm	[INV] [LN]	83.

Numeric Functions

Eight numeric functions are available as selections on the NUMBER FUNCTIONS menu. You access the menu when you select the numeric (NUM) function.

The Number Functions Menu

When you press the [NUM] key, a menu appears. Each of the menu selections is explained in the following pages.

```
NUMBER FUNCTIONS
INT  FRC  R#  RND  -->
```

⟨INT⟩	Discards the fraction and keeps the integer
⟨FRC⟩	Discards the integer and keeps the fraction
⟨R#⟩	Generates a random number
[INV] ⟨R#⟩	Enables you to enter a seed number to generate a predictable random number sequence
⟨RND⟩	Rounds a number internally to the display format (scientific, engineering, standard, or fixed)
⟨-->⟩	Displays the selections shown below

```
NUMBER FUNCTIONS
SGN  LCM  PF  ABS  -->
```

⟨SGN⟩	Calculates the signum (sign) of a number
⟨LCM⟩	Calculates the least common multiple and greatest common divisor of a number
⟨PF⟩	Determines the lowest prime factor of a number
⟨ABS⟩	Changes a number to its absolute value
⟨-->⟩	Displays the selections shown above

Integer Portion, Fractional Portion, and Rounding

You can choose to discard a portion of a number that you consider insignificant or unimportant to the problem you are solving. You can do this using the integer portion, fractional portion, or rounding functions. These functions operate on the internal value, not the displayed value.

Integer Portion

Selecting ⟨INT⟩ from the **NUMBER FUNCTIONS** menu discards the fractional portion of the internal value and retains only the integer portion.

If the displayed value is the same as the internal value, the integer portion remains the same and the fractional portion is discarded. Because this function operates on the internal value, if the two values are not the same, selecting the INT function may produce an unexpected result as shown in the example below. You can use the 2nd [13d] key sequence to check the internal value before using the INT function.

Fractional Portion

Selecting ⟨FRC⟩ from the **NUMBER FUNCTIONS** menu discards the integer portion of the internal value and retains only the fractional portion.

If the displayed value is the same as the internal value, the fractional portion remains the same and the integer portion is discarded. Because this function operates on the internal value, if the two values are not the same, selecting the FRC function may produce an unexpected result as shown in the example below. You can use the 2nd [13d] key sequence to check the internal value before using the FRC function.

Example

The example below illustrates the operation of the INT and FRC functions.

Internal Value	Displayed Value	Integer Portion	Fractional Portion
−65.231	−65.231	−65.	−0.231
.9999999999991	1.	0.	1.
1.999999999998	2.	1.	1.

Rounding

Selecting ⟨RND⟩ from the **NUMBER FUNCTIONS** menu changes the internal value to match the value that is displayed.

You can use the RND function with standard, scientific, or engineering notation. You can also use it with fixed decimal.

Example

The example below illustrates the operation of the RND function.

Procedure	Press	Display
Clear display	CLEAR	0.
Enter π	2nd [π]	3.141592654
Check internal value	2nd [13d]	+3141592653590
Round internal value	NUM ⟨RND⟩	3.141592654
Check internal value	2nd [13d]	+3141592654000
Calculate 2 times .9999999999991 99	.9999999999991 EE 99 × 2 =	2. 99
Check internal value	2nd [13d]	+1999999999998
Round and verify internal value	⟨RND⟩ 2nd [13d]	+2000000000000

The value is changed internally to the same value as that in the display.

Prime Factors

You can use the calculator to determine the prime factors of a whole number.

Calculating Prime Factors

Selecting ⟨PF⟩ from the **NUMBER FUNCTIONS** menu finds the lowest prime factor of the displayed value. To use the PF function:

1. Enter the number.
2. Press [NUM] and select ⟨-->⟩.
3. Select ⟨PF⟩. The least prime factor is displayed and the remaining value is stored in the t-register (temporary register).
4. Press [x<>t]. The remaining value is displayed.
5. Repeat steps 3 and 4 until the result is 1.

Note: If the first displayed factor of a number is 1, the number is prime.

Example

Find the prime factors of 102.

Procedure	Press		Display
Clear display	[CLEAR]		0.
Enter a number	102		102
Calculate least prime factor	[NUM] ⟨-->⟩ ⟨PF⟩	f=	2.
Display remaining value	[x<>t]		51.
Calculate next factor	⟨PF⟩	f=	3.
Display remaining value	[x<>t]		17.
Calculate next factor	⟨PF⟩	f=	1.

The prime factors are 2, 3, and 17.

Common Multiples and Common Divisors

One of the selections on the NUMBER FUNCTIONS menu lets you calculate least common multiples and greatest common divisors.

The LCM Function

Selecting ⟨LCM⟩ from the **NUMBER FUNCTIONS** menu calculates both the least common multiple and the greatest common divisor of two numbers.

Because this function requires two numbers for the comparison and calculates two results, a separate storage area is required. You must store one number in the t-register and place the other number in the display. The function places the least common multiple in the display and stores the greatest common divisor in the t-register.

To use the LCM function:

1. Enter one of the numbers and press [x<>t] to store the number in the t-register.
2. Enter the other number and press [NUM] ⟨-->⟩ ⟨LCM⟩ to perform the calculation and display the least common multiple.
3. Press [x<>t] to display the greatest common divisor.

Example

Determine the least common multiple and greatest common divisor of the numbers 36 and 48.

Procedure	Press		Display
Clear display	[CLEAR]		0.
Enter the two numbers	36 [x<>t] 48		48
Display LCM (GCD stored in t-register)	[NUM] ⟨-->⟩ ⟨LCM⟩	LCM =	144.
Display GCD	[x<>t]		12.

Absolute and Signum Functions

You can use the calculator to determine the absolute value and signum function of a number.

Absolute Values

Selecting ⟨ABS⟩ from the **NUMBER FUNCTIONS** menu changes the number in the display to its absolute value.

Example

Calculate $|3 \div 10 - 2| \times 11$.

Procedure	Press	Display
Clear display	CLEAR	0.
Perform the calculation	(3 ÷ 10 − 2)	−1.7
Calculate the absolute value	NUM ⟨-->⟩ ⟨ABS⟩	1.7
Multiply the absolute value by 11	× 11 =	18.7

Signum Function

Selecting ⟨SGN⟩ from the **NUMBER FUNCTIONS** menu determines the sign of the number in the display and results in either a 1 or −1, depending on the sign.

Value in Display	Signum
0 or greater	1
Less than 0	−1

For example, if the display contains −0.941863 and you press NUM ⟨-->⟩ ⟨SGN⟩, the calculator displays −1.

Random Numbers

You can use the calculator to produce random numbers. Entering a seed value allows you to reproduce a random sequence.

Generating Random Numbers

You can use the R# function to generate a sequence of uniformly distributed, random decimal numbers between 0 and 1. To use the R# function, press NUM ⟨R#⟩.

The random number generator begins at a random point and generates a unique sequence. Each time the calculator is turned off and back on, a new random sequence can be generated.

You can also "seed" the generator to produce the same sequence of numbers each time you enter the same seed. To seed the generator:

1. Enter a seed number (0 or any number between 1 and 100, not including 100). If you enter numbers outside this range, they duplicate the action of other seed numbers.
2. Press INV ⟨R#⟩.

Example

Generate a predictable sequence of random numbers, and then verify the seed will regenerate the same sequence.

Procedure	Press	Display
Clear display	CLEAR	0.
Enter seed value	8.2 NUM INV ⟨R#⟩	8.2
Display random number	⟨R#⟩	.5333248654
Display random number	⟨R#⟩	.4256753429
Display random number	⟨R#⟩	.9490727541
Reenter seed value	8.2 INV ⟨R#⟩	8.2
Display random number	⟨R#⟩	.5333248654

Extended Functions

The extended functions consist of three selections that enable you to find roots of quadratic and cubic equations and to access the contents of the system registers.

The Extended Functions Menu

When you press the FUNC key, the following menu appears.

```
EXTENDED FUNC
QAD  CUB  SYS
```

⟨QAD⟩	Selects quadratic equation roots
⟨CUB⟩	Selects cubic equation roots
⟨SYS⟩	Selects system functions

Note: The ⟨SYS⟩ selection provides access to system register contents. You should use this selection only if you have sufficient knowledge of the internal operations of the calculator. Refer to the *TI-95 Programming Guide* for information concerning the ⟨SYS⟩ selection.

Quadratic Equations

The ⟨QAD⟩ selection requires you to enter the coefficients of your equation. An equation in quadratic form has coefficients a, b, and c:

$ax^2 + bx + c = 0$

Finding Quadratic Roots

Select ⟨QAD⟩ from the **EXTENDED FUNC** menu to display the **QUADRATIC EQN** menu.

```
QUADRATIC EQN
a    b    c    XEQ
```

1. Enter the value of the a coefficient and select ⟨a⟩.
2. Enter the value of the b coefficient and select ⟨b⟩.
3. Enter the value of the c coefficient and select ⟨c⟩.
4. Select ⟨XEQ⟩. One of the menus below is displayed.

```
REAL ROOTS
R1   R2
```

```
COMPLEX ROOTS
Re   Im
```

5. If the roots are real, display the two roots by selecting:

⟨R1⟩	The first real root
⟨R2⟩	The second real root

6. If the roots are complex, display the real and imaginary parts by selecting:

⟨Re⟩	The real part
⟨Im⟩	The imaginary part

The two roots are Re + (Im)i and Re – (Im)i.

(continued)

Finding Quadratic Roots (Continued)

Data registers 000, 001, and 002 are used to store both the inputs and the results. As the values for a, b, and c are entered, they are stored in registers 000, 001, and 002, respectively. After the two roots are determined, they are stored in registers 000 and 001. Register 002 contains a 0 if the roots are real and a 1 if the roots are complex. Therefore, the original inputs are no longer available in the registers.

Quadratic Example

Find the roots of the equation $4.2x^2 + .22x + 8 = 0$.

Procedure	Press		Display
Clear display	CLEAR		0.
Select quadratic roots	FUNC ⟨QAD⟩	QUADRATIC EQN	
Enter value for a	4.2 ⟨a⟩	a=	4.2
Enter value for b	.22 ⟨b⟩	b=	0.22
Enter value for c	8 ⟨c⟩	c=	8.
Determine roots	⟨XEQ⟩	COMPLEX ROOTS	
Display real part	⟨Re⟩	Re=	−.0261904762
Display imaginary part	⟨Im⟩	Im=	1.379882591

The two roots are:

$-.0261904762 + (1.379882591)i$
$-.0261904762 - (1.379882591)i$

Cubic Equations

The ⟨CUB⟩ selection requires you to enter the coefficients of your equation. An equation in cubic form has coefficients a, b, c, and d:

$ax^3 + bx^2 + cx + d = 0$

Finding Cubic Roots

Select ⟨CUB⟩ from the **EXTENDED FUNC** menu to display the **CUBIC EQN** menu.

```
CUBIC EQN
a   b   c   d   XEQ
```

1. Enter the value of the a coefficient and select ⟨a⟩.
2. Enter the value of the b coefficient and select ⟨b⟩.
3. Enter the value of the c coefficient and select ⟨c⟩.
4. Enter the value of the d coefficient and select ⟨d⟩.
5. Select ⟨XEQ⟩. Depending on the results, one of the following menus is displayed.

```
REAL ROOTS
R1   R2   R3
```

```
2 COMPLEX, 1 REAL
Re   Im   R3
```

The results are obtained using the procedure on the next page.

Finding Cubic Roots (Continued)

6. If the roots are real, display the three roots by selecting:

   ⟨R1⟩ The first real root

   ⟨R2⟩ The second real root

   ⟨R3⟩ The third real root

7. If there are two complex roots and one real root, display the results by selecting:

   ⟨Re⟩ The real part of the complex roots

   ⟨Im⟩ The imaginary part of the complex roots

   ⟨R3⟩ The real root

   The complex roots are Re + (Im)i and Re − (Im)i.

Data registers 000, 001, 002, and 003 are used to store both the inputs and the results. As the values for a, b, c, and d are entered, they are stored in registers 000, 001, 002, and 003, respectively. After the three roots are determined, they are stored in registers 000, 001, and 002. Register 003 contains a 0 if all roots are real and a 1 if two of the roots are complex. Therefore, the original inputs are no longer available in the registers.

Cubic Example

Find the roots of the equation $3x^3 + 9x^2 - 9x + 3 = 0$.

Procedure	Press		Display
Clear display	CLEAR		0.
Select cubic roots	FUNC ⟨CUB⟩	CUBIC EQN	
Enter value for a	3 ⟨a⟩	a=	3.
Enter value for b	9 ⟨b⟩	b=	9.
Enter value for c	9 +/− ⟨c⟩	c=	−9.
Enter value for d	3 ⟨d⟩	d=	3.
Determine roots	⟨XEQ⟩	2 COMPLEX, 1 REAL	
Display real part	⟨Re⟩	Re=	.4236610509
Display imaginary part	⟨Im⟩	Im=	0.283606001
Display real root	⟨R3⟩	R3=	−3.847322102

The three roots are:

−3.847322102
.4236610509 + (0.283606001)i
.4236610509 − (0.283606001)i