

TI-86 Graphing Calculator Keystroke Guide

In your textbook you will notice that on some pages a key-shaped icon appears next to a brief description of a feature on your graphing calculator. In this guide the page number in the textbook on which each of these icons occurs is shown, as well as the key word or phrase that appears in the box, followed by a detailed description of how to use this feature on your TI-86 graphing calculator. Each feature is also given its own number for easy reference.

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1 Negative and Subtract

You may have noticed that the calculator has two keys with a minus sign on them. The (–) key in the bottom row of keys is actually the **negative key**. **The negative key is used only to write a negative number.** The following numbers and expressions would be entered using the negative key: -5 $-7*6$ $-4+1$ $54/(-6)$.

The – key in the right-hand column on the keyboard with the +, ×, and ÷ keys, is the **subtraction key**. It is grouped with the other keys used to perform the basic four arithmetic operations (addition, subtraction, multiplication, and division). **The subtraction key is used between two numbers to indicate that a subtraction is to be done.** The following expressions would be entered using the black subtraction key: $17-8$ $13*7-2$ $5-6(3+4)$.

You can tell which of these keys has been used from the screen display, if you look closely. The negative sign produced by the negative key is one pixel (dot) shorter and placed one pixel row higher than the subtraction sign produced by the subtraction key.

Be aware that it is a common mistake among new users of the graphing calculator to press the wrong one of these two keys. If you do, sometimes you will get an error message on the calculator screen when you press ENTER to evaluate an expression. Other times the calculator will do something different from what you intend.

For example, suppose you wanted to do the subtraction $8-5$ on the calculator. First do it the correct way with the black subtraction key and press ENTER to evaluate it. Of course, you should get 3 as the answer. Now enter it the wrong way by using the negative key between the 8 and the 5 and press ENTER to evaluate it. The TI-86 displays an answer of -40 . What happened? The calculator does **not** interpret the negative key as meaning to subtract. The calculator sees this last expression as two numbers written side by side, 8 and -5 . The TI-86 interprets the lack of a basic operation key between the numbers to mean an implied multiplication: 8 times -5 .

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2 Mode (Number of Decimal Places Displayed)

Press 2nd [MODE] (the second function on the MORE key). The second line of the Mode screen controls the number of decimal places that the calculator will display in its computed results. With the highlight on the word Float, the calculator will display either an exact value with only the

number of decimal places needed to do so, or it will display the full twelve digits it is able to display. If the Mode screen does not already appear as shown below left, use the arrow keys to move the cursor over the word Float, and press ENTER to select it. Press 2nd [QUIT] to return to the Home screen and do the computations shown below the Mode screen on the left.

```
RectI  CylI  SphereI
dxDer1 dxNDer
```

```
9+3                12
19/8                2.375
240/17             14.1176470588
```

```
RectI  CylI  SphereI
dxDer1 dxNDer
```

```
9+3                12.00
19/8                2.38
240/17             14.12
```

Press 2nd [MODE] again, and use the arrow keys to move the cursor over the number 2 on the second line of the Mode screen. Press 2nd [QUIT] to return to the Home screen and do the same computations again. Note how all of the results are displayed rounded to two decimal places, as shown above right.

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3 Square Root

The square root is the second function on the x^2 key. Note the square root sign $\sqrt{}$ printed above the x^2 key in yellow print. To produce a square root sign on the Home screen display, press 2nd [$\sqrt{}$]. Other keystrokes involving the 2nd key will be denoted in a similar fashion. The expression in the brackets should be found printed above one of the keys on the keyboard.

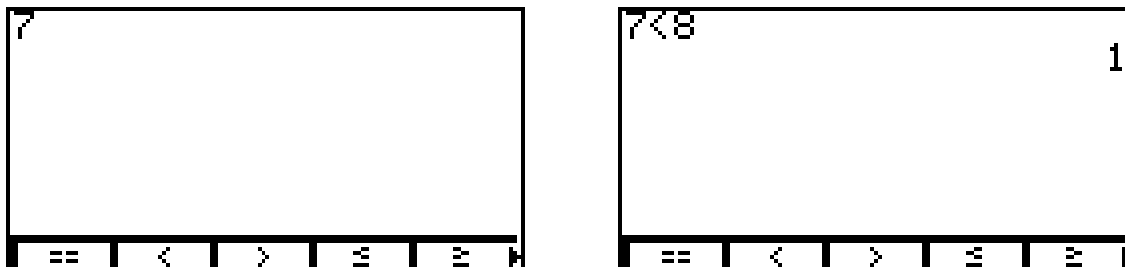
Unlike with most scientific calculators, with the graphing calculator you enter the square root sign first. To find the square root of 324, use the following keystrokes: 2nd [$\sqrt{}$] 324 ENTER. On the Home screen you will see $\sqrt{324}$. The value of this square root, 18, should have appeared on the right of the screen after you pressed ENTER.

Note that the calculator only does the square root of the number immediately following the square root sign. If you want to compute $\sqrt{9+16}$, you must group the sum in parentheses, $\sqrt{(9+16)}$, to assure that the sum is computed before the square root is taken. (The correct value of this expression is 5.) If you do not enclose the sum in parentheses, the calculator will interpret $\sqrt{9+16}$ as $\sqrt{9}+16$, where the square root applies only to the number 9. The value of this expression is 19.

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4 Test

The items on the TEST menu may be used to tell whether a relationship between two numbers or expressions is true or false. To see how it works, let the calculator verify something you already know: 7 is less than 8. At the Home screen type a 7 and then press 2nd [TEST] (the second function on the 2 key) to display the TEST menu at the bottom of the screen.



Select the "less than" symbol $<$ by pressing F2. The $<$ symbol will appear on the Home screen after the 7. Then type an 8, so that the Home screen now shows $7 < 8$. The calculator will tell you whether this statement is true when you press ENTER. The calculator will display a 1 if the statement is true or a 0 if the statement is false. In this case, of course, the calculator displays a 1, since it is true that 7 is less than 8.

Now enter a false statement: $4 > 11$. Type a 4 and then, if the TEST menu is not already displayed, press 2nd [TEST] to display the TEST menu. The "greater than" symbol $>$ is choice F3 on the menu, so press F3 to produce the $>$ symbol on the Home screen after the 4. Now type 11 and press ENTER. The calculator displays a 0 to tell you that the statement is false.

Next try one that perhaps isn't so obvious. Is $\frac{5}{8} > \frac{59}{93}$? Type in $5/8 > 59/93$ (using the division key \div to produce the diagonal slash division sign $/$) and press ENTER to find out. The statement is false, since the calculator responds with a 0.

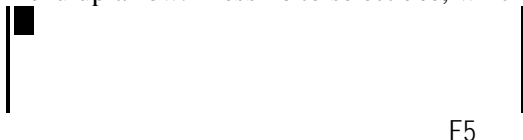
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5 Absolute Value

The absolute value of a number is the number's distance from zero on the number line. On your calculator the absolute value is denoted **abs**. To produce the absolute value character, first press 2nd [MATH] (the second function on the multiplication key \times .) Select the NUM menu by pressing the F1 key at the top of the keyboard.



The calculator will then display the NUM menu at the bottom of the screen and move the MATH menu up a row. Press F5 to select **abs**, which will be displayed on the Home screen.



When we write the absolute value of -7 with pencil and paper, we enclose the number within two vertical bars: $|-7|$. On the calculator the absolute value of -7 is denoted **abs (-7)**. The number or expression (called the **argument**) whose absolute value is to be evaluated is usually enclosed within parentheses (although for absolute values of single numbers, parentheses are optional). The parenthesis keys are above the 8 and 9 keys. Type **abs (-7)** on your Home screen by first producing **abs**, using the keystrokes described above. Then type -7 in parentheses, being

sure to use the negative key, the gray (–) key at the bottom of the keyboard. Press ENTER to find the absolute value of –7, which is 7.



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6 Home

See the first page of the Introduction of the TI-86 part of this *Guide* to see the description of the Home screen.

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7 Add

The addition key + is on the right-hand side of the keyboard with the other basic operation keys (subtraction, multiplication, and division). Basic addition is done as it is on most other kinds of calculators: the expression containing addition may be entered just as it appears in print or when written by hand. To evaluate the expression once you have typed it in, press ENTER. For example, to evaluate $7 + 15$, type this expression just as it appears and press ENTER to display the value 22.

To add expressions involving negative numbers, such as $5 + (-8)$, you may type this expression just as it appears with the parentheses and press ENTER to obtain the value –3. Be sure you use the gray negative key (–), not the black subtraction key, when you type in the –8. (See **1 Negative and Subtract.**) You could also type this expression without using the parentheses, and it will still work: $5 + -8$ will still produce the value –3.

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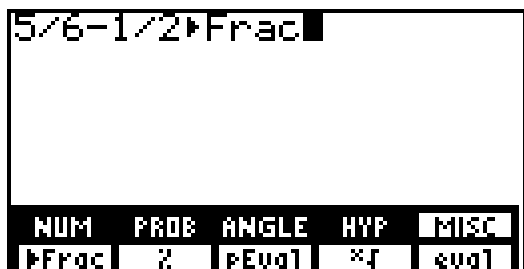
8 Fraction

Fractions may be entered into the calculator by using the division key \div , which produces a diagonal slash fraction bar on screen. Your calculator can perform operations on fractions and give answers in either decimal or fraction form. Enter the expression $\frac{5}{6} - \frac{1}{2}$ by typing

$5 \div 6 - 1 \div 2$. The expression will appear on the Home screen as **5 / 6 - 1 / 2**. Press ENTER to get the decimal form of the value of this expression (approximately .3333333333). If you prefer to get your answer in fractional form, you must do one extra thing before pressing ENTER. To see how to get a fractional answer, either type in the original expression again or use 2nd [ENTRY] to reproduce it on the Home screen. With the cursor at the end of the expression, press 2nd [MATH], F5 (MISC), MORE, F1 ($\frac{\square}{\square}$ Frac). After pressing this key sequence, the screen should display **5 / 6 - 1 / 2 $\frac{\square}{\square}$ Frac**.



Menu display after pressing 2nd [MATH]



F1

After pressing F5 (MISC), MORE, F1 ($\frac{\square}{\square}$).

Now press ENTER to see the fractional value of the expression (one-third).



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9 Subtract and Negative

See **1 Negative and Subtract**.

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10 Multiply

If you type 3×6 , your calculator will display it as $3*6$. The asterisk $*$ is a common computer notation for multiplication. When you press ENTER, the calculator will display the value 18. If you place one or both of the numbers in a multiplication in parentheses *without* using the multiplication key, the calculator still knows that you mean to multiply. Thus, the calculator will also produce 18 if you enter 3×6 as $3(6)$, $(3)6$, or $(3)(6)$. Parentheses may also be used for grouping calculations to be done in a certain order. Thus, the calculator interprets $5(3+4)$ as meaning to add $3 + 4$ first to get 7, and then to multiply 5 times the 7 to get 35.

Your calculator interprets the following as indicating multiplication: the multiplication key \times , numbers or expressions written in side by side in parentheses, and numbers and letters written side by side. Your calculator will also accept letters written side by side with $*$ between them as indicating multiplication. For example, it would interpret $A*B$ as meaning the product AB . The TI-86 accepts variable names that are more than one letter long. Therefore, it will **not** interpret AB as meaning the product of A and B ; it will instead interpret AB as a single variable whose name is AB . If you have not already defined a value for the variable AB (see **11 Store**), the calculator will give an error message when you try to evaluate it.

As an example of placing numbers and letters side by side, the calculator interprets $3X$ as meaning "3 times X ." (How to enter letters will be discussed later.) To see how this way of writing multiplication works, try typing $2p$ where p (the Greek letter pi) represents that special number having to do with circles. The value of p is approximately 3.14159265359. Your calculator has this special number as the second function on the caret key \wedge . (You should see the symbol p printed above the caret key in yellow type.) To type in $2p$ type the 2 and then press 2nd [π]. Your calculator should display $2p$. Press ENTER to see the value 6.28318530718, which is a decimal approximation of two times the value of p .

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11 Divide

The symbol \div appears on the division key of your calculator, but on the screen division is indicated by the diagonal slash $/$. Do the division 24 divided by 6 by pressing $24 \div 6$ ENTER. Note that on the Home screen the division appears as **24/6**, which means the same thing, and the result is still 4.

Fractions may also be entered as divisions. For example, the fraction $\frac{3}{4}$ may be interpreted as 3 divided by 4. You may enter the fraction that way on your calculator. On the screen you will see **3/4**. When you press ENTER, you will see the decimal equivalent of .75. (See also **8 Fraction**.)

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12 Exponent

The caret key \wedge is used to enter most exponents. For example, the expression 2^5 , is entered into the calculator as **2^5**. Thus, the base is entered first, then the caret, and then the exponent. Press ENTER to produce this expression's value, 32. To raise a negative number to a power, it is necessary to enclose the negative number base in parentheses. For example, to raise the number -3 to the fourth power the expression must be written as $(-3)^4$. Likewise, we must enter this expression into the calculator as **(-3)^4**. The result is 81. Without the parentheses, **-3^4** would (and should) be interpreted as taking the negative of 3^4 . That is, **-3^4** is interpreted as $-3^4 = -(3^4) = -(81) = -81$.

The exponent 2 can be displayed on screen as a raised exponent. To enter the expression 5^2 you could use the standard approach of typing **5^2**, or you could instead type the 5 and then press the x^2 key. The x^2 key produces only the raised exponent 2 on the screen, not the x . Either way, the calculator produces the result of 25 when you press ENTER.

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13 Square Root

See **3 Square Root**.

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14 Reciprocal

Since the reciprocal of an integer, such as 5, may be written as $\frac{1}{5}$, it may be entered into the calculator as we would enter any fraction of this type: **1/5**, using the division key \div to produce the diagonal slash $/$ on the screen. Similarly, the reciprocal of a fraction, such as $\frac{5}{8}$, may be written by interchanging the numerator and denominator: $\frac{8}{5}$, appearing as **8/5** on screen.

Another way to enter the reciprocal of a number is to use the x^{-1} feature (the second function on the EE key). For reasons that will be explained later, the reciprocal of 4 may be written as 4^{-1} . To produce this expression on screen, press 4; then press 2nd [x^{-1}], which produces only the exponent -1 , not the x . Press ENTER to display the value of the expression, .25, which is the decimal equivalent of $\frac{1}{4}$. To enter the reciprocal of a fraction such as $\frac{5}{8}$, the fraction must be enclosed in parentheses to ensure that the reciprocal of the entire fraction is computed. Type

$(5/8)^{-1}$ and press ENTER to see the value of the reciprocal of $\frac{5}{8}$, which is displayed as 1.6, the decimal equivalent of $\frac{8}{5}$. If you want the calculator to display the reciprocal in fraction form, use the **>Frac** feature. (See **8 Fraction.**)



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