Getting started

Texas Instruments TI-83 and TI-83 plus calculators

OVERVIEW: *Your graphing calculator or computer is a powerful and flexible tool, which you would probably be able to use fairly well without reading any instructions. It is important, however, to learn how to take advantage of some of its not-so-obvious features and how to avoid making errors using it. Study these instructions and be sure you can work the tune-up exercises at the end.*

Topics:

- ***Basic operations***
- ***Priority of operations in calculations***
- ***Exact and approximate decimal values of functions***

Basic operations

Press the [ON] key to start the calculator. Press [2nd] followed by the up cursor key [▲] to increase display contrast and by [▼] to decrease it. Change the four AAA batteries as soon as the screen dims when graphs are generated.

Press the [MODE] key. The screen should show

Normal Sci Eng	**Connected** Dot
Float 0123456789	**Sequential** Simul
Radian Degree	**Real** a+bi re^θi
Func Par Pol Seq	**Full** Horiz G–T.

The words printed in bold type here should be highlighted on the screen. If another item is highlighted, use the cursor keys to move the flashing box to the correct item and press [ENTER]. <Normal> denotes normal notation for decimals; <Sci> is for scientific notation; and <Eng> for engineering notation. With <Float> selected decimals are printed with 10 digits. Choosing an integer instead of <Float> causes that many digits be shown after decimal points. <Radian> is for radians and <Degree> for degrees. <Func> is selected to generate graphs $y = f(x)$ of functions. <Par> is used with parametric equations, <Pol> is for polar coordinates, and <Seq> is for plotting sequences. Points on graphs are connected by lines if <Connected> is selected; graphs are generated one after another with <Sequential>. With <Real> selected, only real numbers are used; with <a+ib> complex numbers are given in rectangular coordinates; and with <re^θi> complex numbers are displayed in polar coordinates. The entire screen is used for graphs with <Full> and the top half with <Horiz>. With <G–T> graphs are shown on the left and tables on the right.

The [CLEAR] key either clears an entry or returns you to a previous screen. [2nd] activates the yellow commands above the keys. [2nd] [QUIT] returns you to the home screen where calculations are made. If you make an error in a command or calculation, the type of error is given and you have the choice of pressing [1] to cancel the incorrect command, or [2] to go to the error to fix it.

The key [ALPHA] puts the calculator in alpha mode, activating the green letters and other symbols above the keys. Pressing [2nd] [A-LOCK] locks it in alpha mode and then pressing [ALPHA] or [ENTER] takes it out of alpha-lock mode. Entering a number followed by [STO▶], [ALPHA], the letter, and [ENTER] assigns that number to the letter. The number can then be recalled with [ALPHA] followed by the letter.

In the home screen, [2nd] [ENTRY] recalls the last expression that was evaluated so it can be edited, if necessary, and used again. The [ON] key stops the generation of graphs, the running of programs, and other operations. The [ENTER] key can be used to interrupt and resume the generation of graphs.

Refer to the owner's manual for further information.

Priority of operations

The meaning of a formula involving functions, powers, sums, differences, products, and quotients depends on how the formula is interpreted to determine the order in which the operations are performed. Texas Instruments TI-83 calculators generally interpret formulas with the following rules, which are also generally used in manual calculations.

Rule 1 *Operations are performed from left to right, except as described in Rules 2 through 5 below.*

Rule 2 *Expressions inside parentheses are evaluated as soon as they are reached.*

Rule 3 *Addition and subtraction have the lowest priority. If an addition or subtraction is followed by multiplication, division, a power, or a function, the addition or subtraction is postponed until another addition or subtraction or the end of the expression is reached.*

Rule 4 *Multiplication and division have medium priority. If a multiplication or division is followed by a power or a function, the multiplication or division is postponed until the power or function has been evaluated.*

Rule 5 *The taking of powers and evaluation of functions have the highest priority and are performed as soon as they are reached.*

Example 1 **(a)** Calculating $5 + 2\sqrt{9}$ involves addition, multiplication, and the taking of a square root. In what order are these operations perfomed? **(b)** Find the value of $5+2\sqrt{9}$ with your calculator.

SOLUTION **(a)** By Rule 5 above, finding the square root has the highest priority and is performed first, yielding $5 + 2\sqrt{9} = 5 + 2(3)$. Multiplication has the next priority, by Rule 4, and gives $5 + 2(3) = 5 + 6$. The remaining addition gives $5 + 6 = 11$.
(b) Press [5] [+] [2] [2nd] [$\sqrt{}$] [9] [(] so the screen reads $5+2\sqrt{}(9)$. Then press [ENTER] for the answer 11. □

Example 2 **(a)** What steps would you use to evaluate $\dfrac{3(4)}{\sqrt{36}} - \dfrac{10}{8-3}$? **(b)** Find the value of $\dfrac{3(4)}{\sqrt{36}} - \dfrac{10}{8-3}$ with your calculator.

SOLUTION **(a)** Working from left to right, you would first multiply the 3 and 4 to have $\dfrac{12}{\sqrt{36}} - \dfrac{10}{8-3}$. Then you would evaluate the square root, yielding $\dfrac{12}{6} - \dfrac{10}{8-3}$. Dividing 12 by 6 would give $2 - \dfrac{10}{8-3}$. Next, you would perform the subtraction in the remaining denominator to have $2 - \dfrac{10}{5}$. Finally, you would divide 5 into 10 to obtain $2 - 2$ and subtract to obtain the answer 0.
(b) Press [3] [(] [4] [)] [÷] [$\sqrt{}$] [3] [6] [)] [−] [1] [0] [÷] [(] [8] [−] [3] [)] so the screen reads $3(4)/\sqrt{}(36) - 10/(8-3)$. Then press [ENTER] for the value 0. □

The next example shows how using the negation symbol $^-$ for subtraction can lead to an error message or give an incorrect result because a product is calculated instead of a difference.

Example 3 Evaluate the expressions $\pi - \pi$, $\pi\,^-\,\pi$, $8 - 5$, and $8\,^-\,5$, where $-$ is the subtraction symbol and $^-$ is the negation symbol, and explain the results.

SOLUTION Any calculator will give the correct values 0 for $\pi-\pi$ and 3 for $8-5$ using the subtaction key. The TI-83 or TI-83-plus interpret $\pi\,^-\,\pi$ as $\pi(-\pi) = -\pi^2 \doteq -9.869604$ and gives an error message with the command $8\,^-\,5$. □

Exact and approximate decimal values of functions

Since some but not all numbers can be represented exactly as finite decimals, it is important to distinguish exact expressions, such as $\frac{1}{3}$ and π, from decimal approximations, such as 0.33333 and 3.14159. You also need to recognize when coordinates obtained from graphs generated by calculators and computers are approximations.

Example 4 Use your calculator to complete the table below of ten-digit values of $5x^{1/3} = 5\sqrt[3]{x}$ at $x = -27, -30, 4, 6, 8$, and 10. The value $5(-27)^{1/3} = 5(-3) = -15$ is exact, but -15.53616253 is only a decimal approximation of $5(-30)^{1/3}$, which cannot be represented by a finite decimal. Its value to 20 decimal places, for example, is $-15.536162529769294333 9$. Which y-values in the completed table in addition to -15 do you recognize as exact?

x	$y = 5x^{1/3} \doteq$	x	$y = 5x^{1/3} \doteq$
-27	-15	-30	-15.53616253
4		10	
6		8	

SOLUTION You can do these calculations more efficiently by storing the formula for the function. Press [Y =] to access the Y= menu and [CLEAR] to erase any previous formula for Y_1. Press [5] [X,T,θ,n] [∧] [(] [1] [÷] [3] [)] to have $Y_1 = 5X \wedge (1/3)$.

To find the value of the function at $x = -27$, press [2nd] [QUIT] to return to the home screen and press [(–)] [2] [7] [STO▶] [X,T,θ,n] [ALPHA] [:] [VARS] [▶] [1] [1] so the screen reads $-27 \rightarrow X$: Y_1. The colon (above the period key) separates the two commands on the one line. Then press [ENTER] for the value -15 of Y_1 at $x = -27$.

Press [2nd] [ENTRY] to display the last line again, use [◀] to move the cursor to the 2 and press [3] [0] to have $-30 \rightarrow X$: Y_1. Press [ENTER] for the approximate decimal value -15.53616253 of Y_1 at $x = -30$.

Press [2nd] [ENTRY] to display the last line again, use [◀] to move the cursor to the minus sign and press [4] [DEL] [DEL] to have $4 \rightarrow X$: Y_1. Press [ENTER] for the approximate decimal value 7.93700526 of Y_1 at $x = 4$.

Press [2nd] [ENTRY] to display the last line again, use [◀] to move the cursor to the 4 and press [1] [2nd] [INS] [0] to have $10 \rightarrow X$: Y_1. Press [ENTER] for the approximate decimal value 10.77217345 of Y_1 at$x = 10$.

Repeat this process for the other two values in the table below. Only the values at -27 and $x = 8$ are exact because only -27 and 8 of the x-values are perfect cubes.

x	$y = 5x^{1/3} \doteq$	x	$y = 5x^{1/3} \doteq$
-27	-15	-30	-15.53616253
4	7.93700526	10	10.77217345
6	9.085602964	8	10

Exercises

Use your calculator or computer to find the approximate decimal values of the expressions in Exercises 1 through 8. Do not simplify the expressions before entering them and be sure your machine is in radian mode for the trigonometric function in Exercise 1. In some cases extra parentheses are needed to express numerators, denominators, and exponents.

1. **(a)** $\sqrt{6}\,\cos(9/7)$ **(b)** $6\cos(\pi/7^3)$ (Edit the expression from part (a).)

2. $(-5-1.63\times10^{-2})^{-1}$

3. $\dfrac{2+8}{4-6}-3^{5-1}$

4. $A+BC^D$ with $A=7$, $B=6$, $C=5$, and $D=4$ (Store the values first.)

5. $\frac{1}{2}\log_{10}(7)$

6. $\dfrac{1.34\times10^6-4\times10^5}{7.12\times10^{-8}}$

7. $\sqrt{4+7^{8-10}}$

8. $(-32)^{4/5}$

Outlines of solutions

1a. 0.6888851432 • (If your result is 2.448873047, your calculator is not in radian mode.) • Press [2nd] [√] [6] [)] [cos] [9] [÷] [7] [)] to have the screen read $\sqrt{(6)}\cos(9/7)$. Then press [ENTER] for the answer.

1b. 5.999748331 • If your last operation was the calculation of $\sqrt{(6)}\cos(9/7)$, press [2nd] [ENTRY] to put it back on the screen. If you performed other calculations, type $\sqrt{(6)}\cos(9/7)$ again. Press [◀] until the cursor is over the square root sign and press [DEL] to delete it. Move the cursor to the close parentheses after the 6 and delete it. Put the cusor on the 9 and press [2nd] [π] to replace the 9 with π. Put the cursor on the close parenthesis and press [2nd] [INS]. Press [∧] [3] to insert ∧ 3 before the close parenthesis, so the screen reads $6\cos(\pi/7\wedge3)$, and press [ENTER] for the answer.

2. −0.1993501186 • Press [(] [(−)] [5] [−] [1] [.] [6] [3] [2nd] [EE] [(−)] [2] [)] [x^{-1}] to display $(^-5-1.63\text{E}^-2)^{-1}$. ($A\,\text{E}\,n$ stands for $A\times10^n$.) Press [ENTER] for the answer. Notice that [(−)] is for negation, [−] is for subtraction, and [x^{-1}] is for taking reciprocals.

3. −86 • Use [(] [2] [+] [8] [)] [÷] [(] [4] [−] [6] [)] [−] [3] [∧] [(] [5] [−] [1] [)] to display $(2+8)/(4-6)-3\wedge(5-1)$. Press [ENTER] for the answer.

4. 3757 • To put the commands on one line for possible later editing, press [7] [STO▶] [ALPHA] [A] [ALPHA] [:] [6] [STO▶] [ALPHA] [B] [ALPHA] [:] [5] [STO▶] [ALPHA] [C] [ALPHA] [:] [4] [STO▶] [ALPHA] [D] [ALPHA] [:] [ALPHA] [A] [+] [ALPHA] [B] [ALPHA] [C] [∧] [ALPHA] [D] so the screen reads $7\to A:6\to B:5\to C:4\to D$: $A+BC\wedge D$. Press [ENTER] to store the values of A, B, C and D and calculate the answer.

5. 0.42254902 • Use [(] [1] [÷] [2] [)] [LOG] [7] [)] [ENTER].

6. 1.320224719×10^{13} • Use [(] [1] [.] [3] [4] [2nd] [EE] [6] [−] [4] [2nd] [EE] [5] [)] [÷] [(] [7] [.] [1] [2] [2nd] [EE] [(−)] [8] [)] [ENTER].

7. 2.00509555 • Use [2nd] [√] [4] [+] [7] [∧] [(] [8] [−] [1] [0] [)] [)] [ENTER].

8. 16 • Use [(] [(-)] [3] [2] [)] [∧] [(] [4] [÷] [5] [)] [ENTER].