Calculator Instructions

Texas Instruments TI-84 Plus

Contents:

A BASIC FUNCTIONS

GROUPING SYMBOLS (BRACKETS)

The TI-84 Plus has bracket keys that look like [( ] and [ )].

Brackets are regularly used in mathematics to indicate an expression which needs to be evaluated before other operations are carried out.

For example, to evaluate $2 \times (4 + 1)$ we type 2 [×] [( ] 4 [+] 1 [ )] [ENTER].

We also use brackets to make sure the calculator understands the expression we are typing in.

For example, to evaluate $\frac{2}{4+1}$ we type 2 [÷] [( ] 4 [+] 1 [ )] [ENTER].

If we typed 2 [÷] 4 [+] 1 [ENTER] the calculator would think we meant $\frac{2}{4} + 1$.

In general, it is a good idea to place brackets around any complicated expressions which need to be evaluated separately.

POWER KEYS

The TI-84 Plus has a power key that looks like [∧]. We type the base first, press the power key, then enter the index or exponent.

For example, to evaluate 25^3 we type 25 [∧] 3 [ENTER].

Numbers can be squared on the TI-84 Plus using the special key [x^2].

For example, to evaluate 25^2 we type 25 [x^2] [ENTER].

ROOTS

To enter roots on the TI-84 Plus we need to use the secondary function key [2nd].

We enter square roots by pressing [2nd] [x^2].

For example, to evaluate $\sqrt{36}$ we press [2nd] [x^2] 36 [ )] [ENTER].

The end bracket is used to tell the calculator we have finished entering terms under the square root sign.

Cube roots are entered by pressing [MATH] **4:** $\sqrt[3]{\ }$ (.

To evaluate $\sqrt[3]{8}$ we press [MATH] **4** 8 [ )] [ENTER].

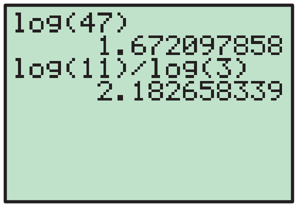
Higher roots are entered by pressing [MATH] **5:** $\sqrt[x]{\ }$.

To evaluate $\sqrt[4]{81}$ we press 4 [MATH] **5** 81 [ENTER].

LOGARITHMS

We can perform operations involving logarithms in base 10 using the [log] button.

To evaluate $\log(47)$, press [log] 47 [)] [ENTER].



Since $\log_a b = \dfrac{\log b}{\log a}$, we can use the base 10 logarithm to calculate logarithms in other bases.

To evaluate $\log_3 11$, we note that $\log_3 11 = \dfrac{\log 11}{\log 3}$, so we press [log] 11 [)] [÷] [log] 3 [)] [ENTER].

INVERSE TRIGONOMETRIC FUNCTIONS

The inverse trigonometric functions $\sin^{-1}$, $\cos^{-1}$, and $\tan^{-1}$ are the secondary functions of [SIN], [COS], and [TAN] respectively. They are accessed by using the secondary function key [2nd].

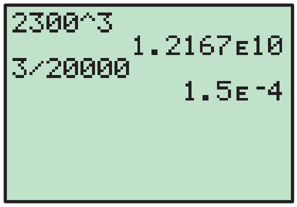
For example, if $\cos x = \frac{3}{5}$, then $x = \cos^{-1}\left(\frac{3}{5}\right)$.

To calculate this, press [2nd] [COS] 3 [÷] 5 [)] [ENTER].

SCIENTIFIC NOTATION

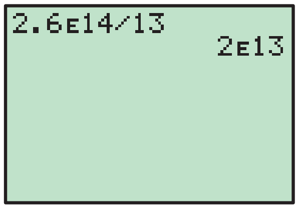
If a number is too large or too small to be displayed neatly on the screen, it will be expressed in scientific notation, which is the form $a \times 10^k$ where $1 \leqslant a < 10$ and k is an integer.

To evaluate 2300^3, press 2300 [∧] 3 [ENTER]. The answer displayed is 1.2167E10, which means 1.2167×10^{10}.



To evaluate $\dfrac{3}{20\,000}$, press 3 [÷] 20 000 [ENTER]. The answer displayed is 1.5E−4, which means 1.5×10^{-4}.

You can enter values in scientific notation using the EE function, which is accessed by pressing [2nd] [,].



For example, to evaluate $\frac{2.6\times 10^{14}}{13}$, press 2.6 [2nd] [,] 14 [÷] 13 [ENTER]. The answer is 2×10^{13}.

SECONDARY FUNCTION AND ALPHA KEYS

The **secondary function** of each key is displayed in blue above the key. It is accessed by pressing the [2nd] key, followed by the key corresponding to the desired secondary function. For example, to calculate $\sqrt{36}$, press [2nd] [x^2] ($\sqrt{\ }$) 36 [)] [ENTER].

The **alpha function** of each key is displayed in green above the key. It is accessed by pressing the [ALPHA] key followed by the key corresponding to the desired letter. The main purpose of the alpha keys is to store values into memory which can be recalled later.

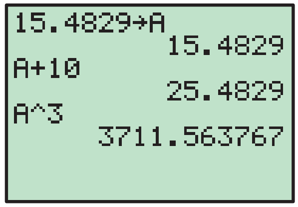
B MEMORY

Utilising the memory features of your calculator allows you to recall calculations you have performed previously. This not only saves time, but also enables you to maintain accuracy in your calculations.

SPECIFIC STORAGE TO MEMORY

Values can be stored into the variable letters A, B, ..., Z. Storing a value in memory is useful if you need that value multiple times.

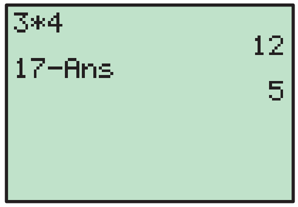
Suppose we wish to store the number 15.4829 for use in a number of calculations. To store this number in variable A, type in the number, then press [STO▶] [ALPHA] [MATH] (**A**) [ENTER].



We can now add 10 to this value by pressing [ALPHA] [MATH] [+] 10 [ENTER], or cube this value by pressing [ALPHA] [MATH] [^] 3 [ENTER].

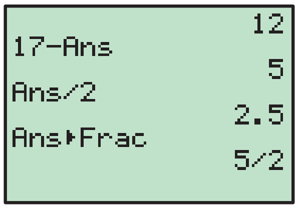
ANS VARIABLE

The variable **Ans** holds the most recent evaluated expression, and can be used in calculations by pressing [2nd] [(−)].



For example, suppose you evaluate 3×4, and then wish to subtract this from 17. This can be done by pressing 17 [−] [2nd] [(−)] [ENTER].

If you start an expression with an operator such as [+], [−], etc, the previous answer **Ans** is automatically inserted ahead of the operator. For example, the previous answer can be halved simply by pressing [÷] 2 [ENTER].



If you wish to view the answer in fractional form, press [MATH] **1** [ENTER].

RECALLING PREVIOUS EXPRESSIONS

The **ENTRY** function recalls previously evaluated expressions, and is used by pressing [2nd] [ENTER].

This function is useful if you wish to repeat a calculation with a minor change, or if you have made an error in typing.

Suppose you have evaluated $100+\sqrt{132}$. If you now want to evaluate $100+\sqrt{142}$, instead of retyping the command, it can be recalled by pressing [2nd] [ENTER].

The change can then be made by moving the cursor over the 3 and changing it to a 4, then pressing [ENTER].

If you have made an error in your original calculation, and intended to calculate $1500+\sqrt{132}$, again you can recall the previous command by pressing [2nd] [ENTER].

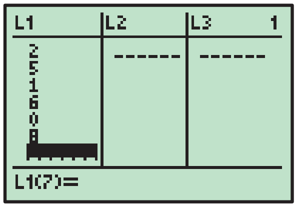
Move the cursor to the first 0.

You can insert the 5, rather than overwriting the 0, by pressing [2nd] [DEL] (**INS**) 5 [ENTER].

C LISTS

Lists are used for a number of purposes on the calculator. They enable us to store sets of data, which we can then analyse and compare.

CREATING A LIST



Press STAT **1** to access the **list editor** screen.

To enter the data {2, 5, 1, 6, 0, 8} into **List 1**, start by moving the cursor to the first entry of **L_1**. Press 2 ENTER 5 ENTER .... and so on until all the data is entered.

DELETING LIST DATA

To delete a list of data from the list editor screen, move the cursor to the heading of the list you want to delete then press CLEAR ENTER .

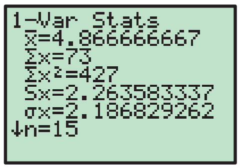
REFERENCING LISTS

Lists can be referenced by using the secondary functions of the keypad numbers 1-6.

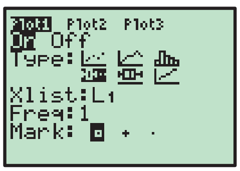
For example, suppose you want to add 2 to each element of **List 1** and display the results in **List 2**. To do this, move the cursor to the heading of **L_2** and press 2nd **1** + 2 ENTER .

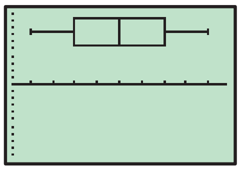
D STATISTICS

Your graphics calculator is a useful tool for analysing data and creating statistical graphs.
We will first produce descriptive statistics and graphs for the data set: 5 2 3 3 6 4 5 3 7 5 7 1 8 9 5.

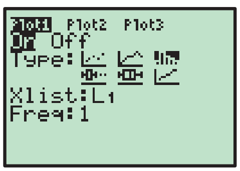


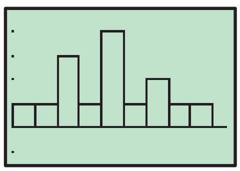
Enter the data set into **List 1**. To obtain descriptive statistics of the data set, press STAT ▶ **1:1-Var Stats** 2nd **1** (**L_1**) ENTER .





To obtain a boxplot of the data, press 2nd Y= (**STAT PLOT**) **1** and set up **Plot1** as shown. Press ZOOM **9:ZoomStat** to graph the boxplot with an appropriate window.



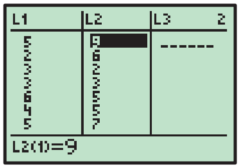


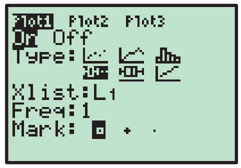
To obtain a vertical bar chart of the data, press 2nd Y= **1**, and change the type of graph to a vertical bar chart as shown. Press ZOOM **9:ZoomStat** to draw the bar chart.

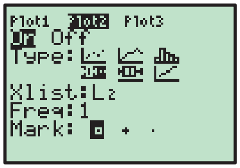
Press WINDOW and set the **Xscl** to 1, then GRAPH to redraw the bar chart.

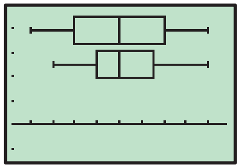
We will now enter a second set of data, and compare it to the first.

Enter the data 9 6 2 3 5 5 7 5 6 7 6 3 4 4 5 8 4 into **List 2**, press [2nd] [Y=] **1**, and change the type of graph back to a boxplot as shown. Move the cursor to the top of the screen and select **Plot2**. Set up **Plot2** in the same manner, except set the **XList** to **L**$_2$. Press [ZOOM] **9:ZoomStat** to draw the side-by-side boxplots.







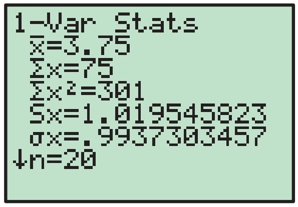


STATISTICS FROM GROUPED DATA

To obtain descriptive statistics for the data in the table alongside, enter the data values into **List 1**, and the frequency values into **List 2**.

Press [STAT] [▶] **1 : 1-Var Stats** [2nd] **1** (**L**$_1$) [,] [2nd] **2** (**L**$_2$) [ENTER] .

Data	*Frequency*
2	3
3	4
4	8
5	5



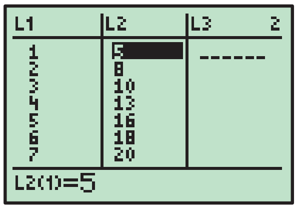
E LINEAR MODELLING

Given a set of bivariate data, we can use our calculator to draw a scatter diagram of the data, find Pearson's correlation coefficient r, and find the line of best fit for the data.

Consider the bivariate data:

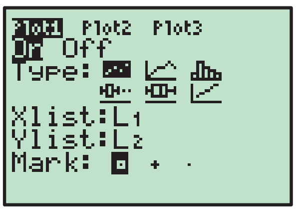
x	1	2	3	4	5	6	7
y	5	8	10	13	16	18	20

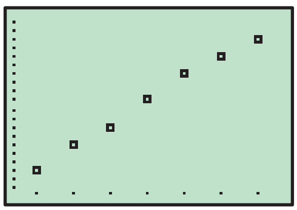
We first enter the x values into **List 1** and the y values into **List 2**.



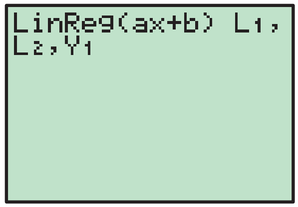
DRAWING A SCATTER DIAGRAM

To produce a scatter diagram for the data, press [2nd] [Y=] (**STAT PLOT**) **1**, and set up **Plot 1** as shown. Press [ZOOM] **9:ZoomStat** to draw the scatter diagram.



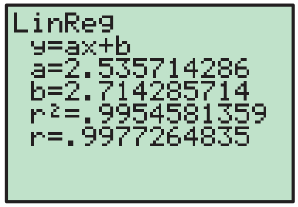


FINDING r AND THE LINE OF BEST FIT



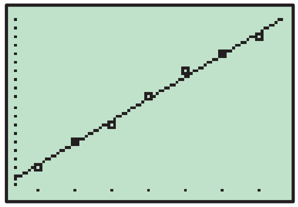
To find r and the line of best fit, press [STAT] [▶] **4:LinReg(ax+b)**, which selects the linear regression option from the CALC menu.

Press [2nd] **1** (L_1) [,] [2nd] **2** (L_2) [,] [VARS] [▶] **1 1** (Y_1). This specifies the lists L_1 and L_2 as the lists which hold the data, and the line of best fit will be pasted into the function Y_1. (Entering the variable Y_1 is optional, and is only required if you want to graph the line of best fit.)



Press [ENTER] to view the results.

We can see that $r \approx 0.998$, and the line of best fit is given as $y \approx 2.54x + 2.71$. If the r value is not shown, you need to turn on the Diagnostic by pressing [2nd] **0** (**CATALOG**) and selecting **DiagnosticOn**.



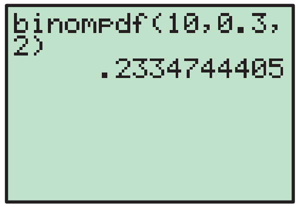
Press [GRAPH] to view the line of best fit.

F PROBABILITY

BINOMIAL PROBABILITIES

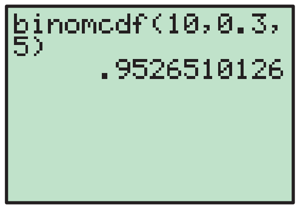
To find $P(X = 2)$ for $X \sim B(10, 0.3)$, press [2nd] [VARS] (**DISTR**) and select **A:binompdf(**. Press 10 [,] 0.3 [,] 2 [)] [ENTER].

So, $P(X = 2) \approx 0.233$.



To find $P(X \leqslant 5)$ for $X \sim B(10, 0.3)$, press [2nd] [VARS] (**DISTR**) and select **B:binomcdf(**. Press 10 [,] 0.3 [,] 5 [)] [ENTER].

So, $P(X \leqslant 5) \approx 0.953$.

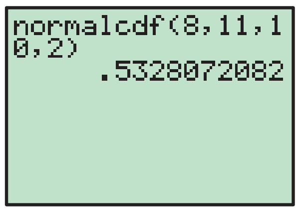


NORMAL PROBABILITIES

Suppose X is normally distributed with mean 10 and standard deviation 2.

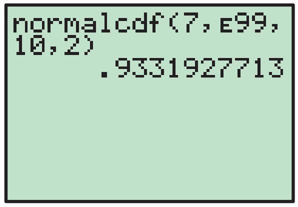
To find $P(8 \leqslant X \leqslant 11)$, press [2nd] [VARS] (**DISTR**), and select **2:normalcdf(**. Press 8 [,] 11 [,] 10 [,] 2 [)] [ENTER].

So, $P(8 \leqslant X \leqslant 11) \approx 0.533$.

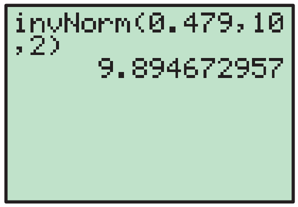


To find $\mathrm{P}(X \geqslant 7)$, press 2nd VARS (**DISTR**), and select **2:normalcdf(**. Press 7 , 2nd , (**EE**) 99 , 10 , 2) ENTER .

So, $\mathrm{P}(X \geqslant 7) \approx 0.933$.



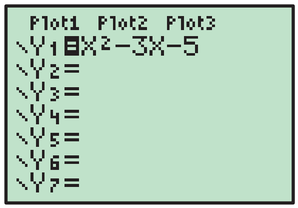
To find a such that $\mathrm{P}(X \leqslant a) = 0.479$, press 2nd VARS (**DISTR**), and select **3:invNorm(**.
Press 0.479 , 10 , 2) ENTER .
So, $a \approx 9.89$.



G WORKING WITH FUNCTIONS

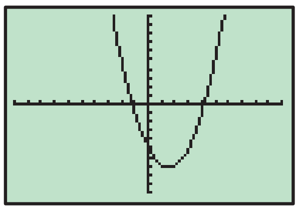
GRAPHING FUNCTIONS

Pressing Y= selects the **Y=** editor, where you can store functions to graph. Delete any unwanted functions by scrolling down to the function and pressing CLEAR .

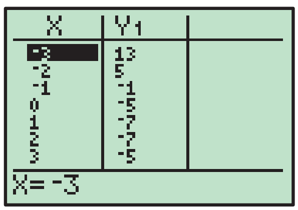


To graph the function $y = x^2 - 3x - 5$, move the cursor to **Y1**, and press X,T,θ,n x^2 − 3 X,T,θ,n − 5 ENTER . This stores the function into **Y1**.

Press GRAPH to draw a graph of the function.



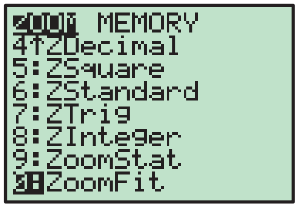
To view a table of values for the function, press 2nd GRAPH (**TABLE**). The starting point and interval of the table values can be adjusted by pressing 2nd WINDOW (**TBLSET**).



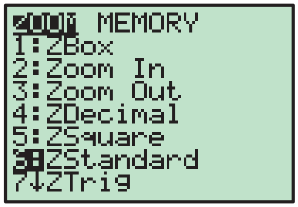
ADJUSTING THE VIEWING WINDOW

When graphing functions it is important that you are able to view all the important features of the graph. As a general rule it is best to start with a large viewing window to make sure all the features of the graph are visible. You can then make the window smaller if necessary.

Some useful commands for adjusting the viewing window include:



ZOOM **0:ZoomFit** : This command scales the y-axis to fit the minimum and maximum values of the displayed graph within the current x-axis range.

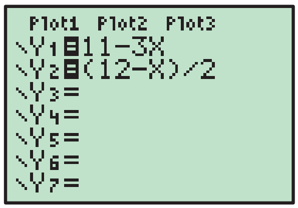


ZOOM **6:ZStandard** : This command returns the viewing window to the default setting of $-10 \leqslant x \leqslant 10$, $-10 \leqslant y \leqslant 10$.

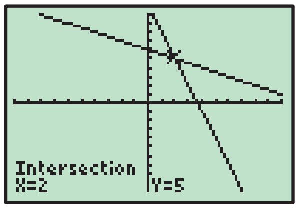
If neither of these commands are helpful, the viewing window can be adjusted manually by pressing WINDOW and setting the minimum and maximum values for the x and y axes.

FINDING POINTS OF INTERSECTION

To find the intersection point of $y = 11 - 3x$ and $y = \frac{12 - x}{2}$, press Y= , then store $11 - 3x$ into $\mathbf{Y}_1$ and $\frac{12 - x}{2}$ into $\mathbf{Y}_2$. Press GRAPH to draw a graph of the functions.



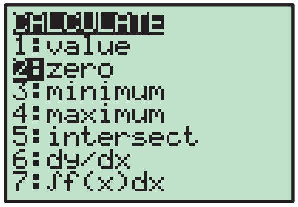
To find their point of intersection, press 2nd TRACE (**CALC**) **5:intersect**. Press ENTER twice to specify the functions $\mathbf{Y}_1$ and $\mathbf{Y}_2$ as the functions you want to find the intersection of, then use the arrow keys to move the cursor close to the point of intersection and press ENTER once more.



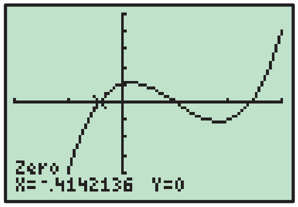
The graphs intersect at $(2, 5)$.

FINDING x-INTERCEPTS

To find the x-intercepts of $f(x) = x^3 - 3x^2 + x + 1$, press [Y=] and store $x^3 - 3x^2 + x + 1$ into **Y1**. Then press [GRAPH].



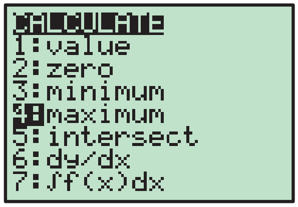
To find where this function first cuts the x-axis, press [2nd] [TRACE] **(CALC) 2:zero**. Move the cursor to the left of the first zero and press [ENTER], then move the cursor to the right of the first zero and press [ENTER]. Finally, move the cursor close to the first zero and press [ENTER] once more. The x-intercept $x \approx -0.414$ is given.



Repeat this process to find the remaining x-intercepts $x = 1$ and $x \approx 2.414$.

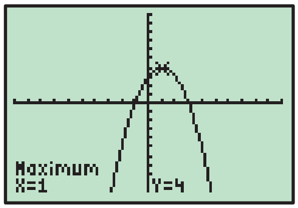
TURNING POINTS

To find the turning point or vertex of $y = -x^2 + 2x + 3$, press [Y=] and store $-x^2 + 2x + 3$ into **Y1**. Press [GRAPH] to draw the graph.



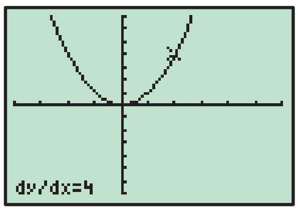
From the graph, it is clear that the vertex is a maximum, so press [2nd] [TRACE] **(CALC) 4 : maximum**.

Move the cursor to the left of the vertex and press [ENTER], then move the cursor to the right of the vertex and press [ENTER]. Finally, move the cursor close to the vertex and press [ENTER] once more. The vertex is (1, 4).

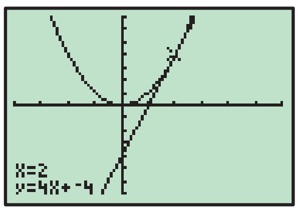


THE TANGENT TO A FUNCTION

To find the gradient of the tangent to $y = x^2$ when $x = 2$, we first draw the graph of $y = x^2$. Press [2nd] [TRACE] **(CALC) 6 : dy/dx**, then press 2 [ENTER]. The tangent has a gradient of 4 at this point.

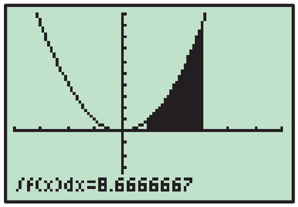


To find the equation of the tangent, press [2nd] [PRGM] **(DRAW) 5 : Tangent**, then press 2 [ENTER]. The tangent has equation $y = 4x - 4$.



DEFINITE INTEGRALS

To calculate $\int_1^3 x^2\,dx$, we first draw the graph of $y = x^2$. Press [2nd] [TRACE] (**CALC**) and select **7:**$\int f(x)\,dx$. Press 1 [ENTER] 3 [ENTER] to specify the lower and upper limits of the integral.



So, $\int_1^3 x^2\,dx = 8\frac{2}{3}$.

Alternatively, you can press [MATH] **9:fnInt(**, then set up the screen as shown.