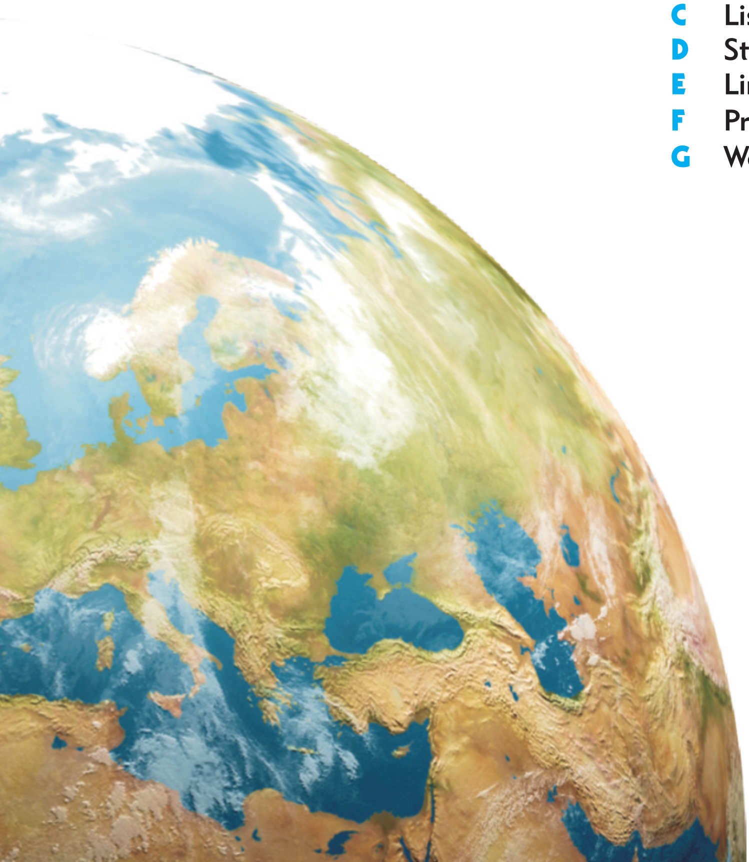
Calculator Instructions

Texas Instruments TI-$n$spire

Contents:



GETTING STARTED

Pressing [home] takes you to the **home screen**, where you can choose which application you wish to use.

The TI-$n$spire organises any work done into **pages**. Every time you start a new application, a new page is created. You can navigate back and forth between the pages you have worked on by pressing [ctrl] [◄] or [ctrl] [►] .

Press [ctrl] [I] **1 : Add Calculator** to open the Calculator application. This is where most of the basic calculations are performed.

SECONDARY FUNCTION KEY

The secondary function of each key is displayed in grey above the primary function. It is accessed by pressing the [ctrl] key followed by the key corresponding to the desired secondary function.

A BASIC FUNCTIONS

GROUPING SYMBOLS (BRACKETS)

The TI-$n$spire 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-$n$spire 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-$n$spire 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-*n*spire we need to use the secondary function `ctrl` .

We enter square roots by pressing `ctrl` x^2 .

For example, to evaluate $\sqrt{36}$ we press `ctrl` x^2 36 `enter` .

You can press the right arrow key ▶ to move the cursor out of the square root sign. For example, to evaluate $\sqrt{18}+5$ we type `ctrl` x^2 18 ▶ $+$ 5 `enter` .

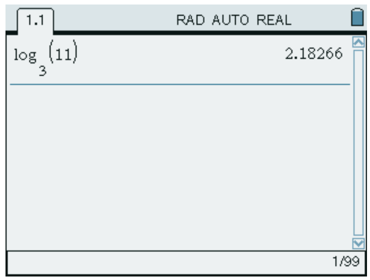
Higher roots are entered by pressing `ctrl` `^` , which creates the $\sqrt[\square]{\square}$ template.
Enter the root number in the first entry, and the number you wish to find the root of in the second entry. Use the arrow keys to navigate around the template.

LOGARITHMS

We can perform operations involving logarithms using the **log** function, which is accessed by pressing `ctrl` 10^x .

Put the base number in the first entry, and the number you wish to find the logarithm of in the second entry.

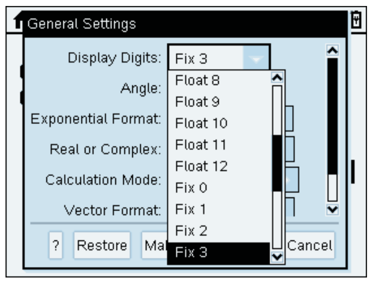
For example, to find $\log_3 11$ press `ctrl` 10^x 3 ▶ 11 `enter` .



ROUNDING OFF

You can instruct the TI-*n*spire to round off values to a fixed number of decimal places.

For example, to round to 3 decimal places, from the home screen select **5 : Settings** > **2 : Settings** > **1 : General**. When the **Display Digits** drop-box is highlighted, press ▶ , then use the ▼ key to select *Fix 3*, and press `enter` .



For most operations, the default setting of *Float 6* is recommended.

You can return to the application you were working on by pressing **4 : Current** from the home screen.

DECIMAL EXPANSION OF FRACTIONS

If you press 5 ÷ 8 `enter` , the calculator will simply return the fraction $\frac{5}{8}$. To find the decimal expansion of $\frac{5}{8}$, press 5 ÷ 8 `ctrl` `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 [ctrl].

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

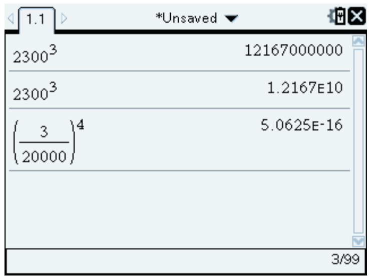
To calculate this, press [ctrl] [cos] 3 [÷] 5 [)] [enter].

SCIENTIFIC NOTATION

Very large and very small numbers can be expressed in scientific notation, which is in the form $a \times 10^k$ where $1 \leqslant a < 10$ and k is an integer.

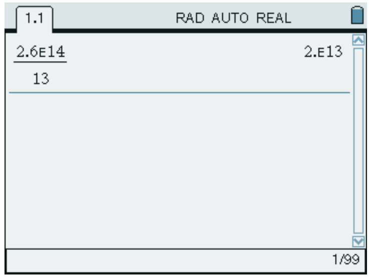
To evaluate 2300^3, press 2300 [^] 3 [enter]. To express this in scientific notation, press [ctrl] [enter]. The answer displayed is 1.2167E10, which means 1.2167×10^{10}.

To express $\left(\frac{3}{20\,000}\right)^4$ in scientific notation, press [(] 3 [÷] 20 000 [)] [^] 4 [ctrl] [enter]. The answer is 5.0625×10^{-16}.



You can enter values in scientific notation using the (EE) key.

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



B MEMORY

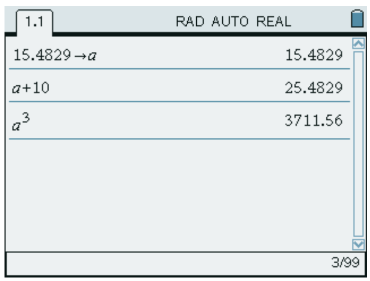
Utilising the memory features of your calculator allows you to recall calculations you have performed previously. This not only saves time, but also enables you to maintain accuracy in your calculations.

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 [ctrl] [var] **(sto▶)** (A) [enter].

We can now add 10 to this value by pressing (A) [+] 10 [enter] or cube this value by pressing (A) [^] 3 [enter].



ANS VARIABLE

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

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

RECALLING PREVIOUS EXPRESSIONS

Pressing the [▲] key allows you to recall and edit previously evaluated expressions.

To recall a previous expression, press the [▲] key until the desired expression is highlighted, and press [enter] . The expression then appears in the current entry line, where it can be edited.

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.

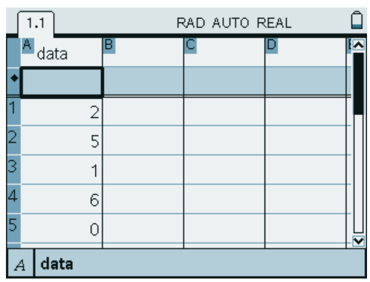
In order to perform many of the operations involving data lists on the TI-*n*spire, you need to **name** your lists as you define them.

CREATING A LIST

Pressing [ctrl] [⌂] **4 : Lists & Spreadsheet** takes you to the **list editor** screen.

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

Move the cursor to the heading of **List A** and use the green alphabet keys to enter a name for the list, for example *data*.

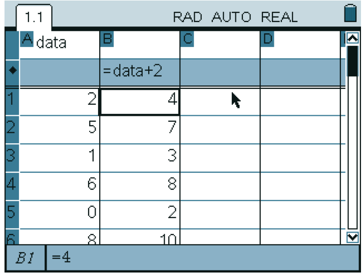


DELETING LIST DATA

To delete a list of data from the list editor screen, move the cursor to the heading of that list, and press [▲] to highlight the whole column. Press [←] to delete the list.

REFERENCING LISTS

Once you have named a list, you can use that name to reference the list in other operations.



Suppose you want to add 2 to each element of the *data* list we created in the above example, and display the results in **List B**.

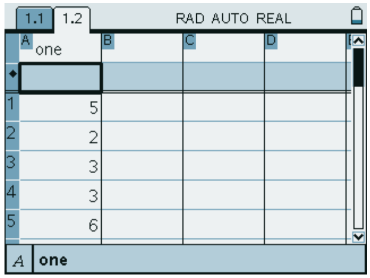
Move the cursor to the second row of **List B**, and press ⊜ *data* + 2 enter .

D STATISTICS

Your graphics calculator is a useful tool for analysing data and creating statistical graphs.

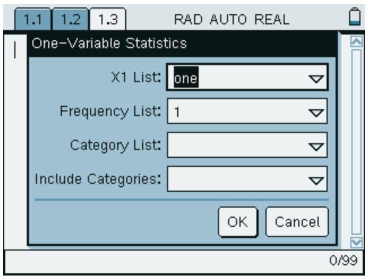
We will first produce descriptive statistics and graphs for the data set: 5 2 3 3 6 4 5 3 7 5 7 1 8 9 5.

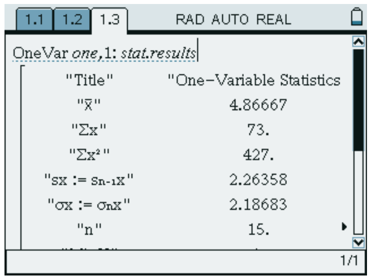
Enter the data into **List A** and name this list *one*.



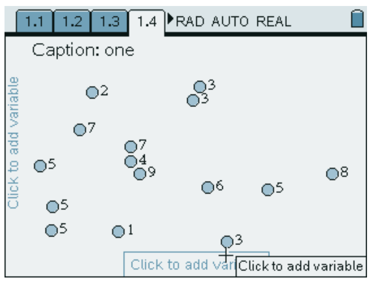
To obtain the descriptive statistics, press ctrl I **1 : Add Calculator** to open the Calculator application, press menu , then select **6 : Statistics** > **1 : Stat Calculations ...** > **1 : One-Variable Statistics**.

Press enter to choose 1 list. Select *one* from the **X1 List** drop-box, and press enter .



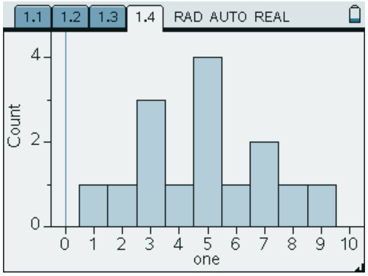


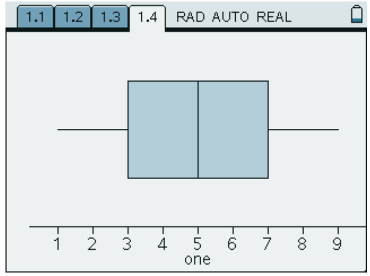
We will now draw some statistical graphs for the data. Press ctrl I **5 : Data & Statistics** to open the Data and Statistics application. You will see the data points randomly scattered on the screen. Move the cursor to the bottom of the screen until the "Click to add variable" box appears. Press enter , then select *one*. The points will order themselves into a dotplot along the horizontal axis.



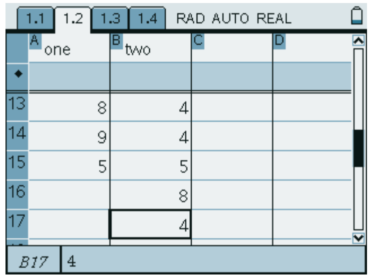
To obtain a vertical bar chart of the data, press menu, then select **1 : Plot Type** > **3 : Histogram**.

To obtain a boxplot of the data, press menu, then select **1 : Plot Type** > **2 : Box Plot**.





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

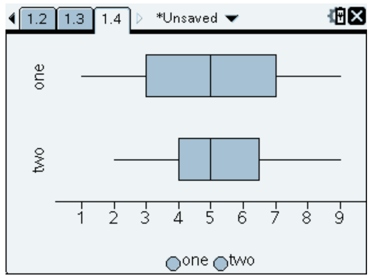


Use the ctrl ◄ command to return to the page containing the list of data.

Enter the set 9 6 2 3 5 5 7 5 6 7 6 3 4 4 5 8 4 into **List B**, and name the list *two*.

Use the ctrl ► command to navigate back to the page containing the boxplot of *one*.

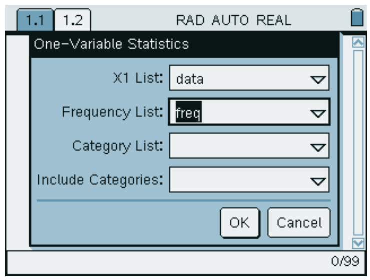
To view boxplots of both data sets, press menu, then select **2 : Plot Properties** > **5 : Add X Variable**. Select *two* from the box.



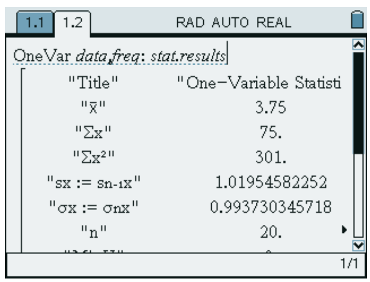
STATISTICS FROM GROUPED DATA

To obtain descriptive statistics for the data in the table alongside, enter the data values into **List A**, and label the list *data*. Enter the frequency values into **List B**, and label the list *freq*.

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



Press ctrl (I) 1 to open the Calculator application. Press menu, then select **6 : Statistics** > **1 : Stat Calculations** > **1 : One-Variable Statistics**. Press enter to choose 1 list. Select *data* from the **X1 List** drop-box and *freq* from the **Frequency List** drop-box, then press enter .



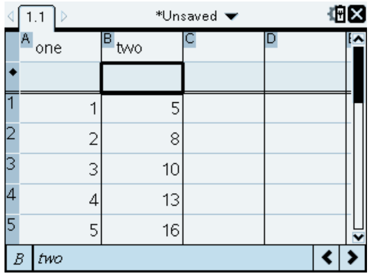
E LINEAR MODELLING

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 A** and label the list *one*, then enter the y values into **List B** and label the list *two*.

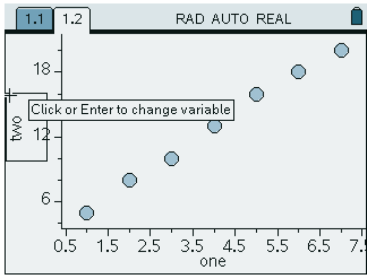


DRAWING A SCATTER DIAGRAM

To produce a scatter diagram for the data, press ctrl **5 : Data & Statistics**.

Move the cursor to the bottom of the screen until the "Click or enter to add variable" box appears. Press enter , then select *one*.

Move the cursor to the left side of the screen, and select *two* for the variable on the vertical axis.

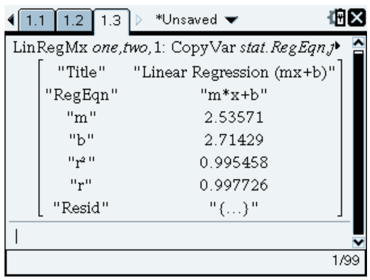


FINDING r AND THE LINE OF BEST FIT

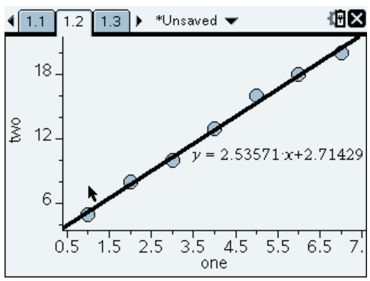
We will now find r and the line of best fit.

Press ctrl **1 : Calculator** menu , then select **6 : Statistics > 1 : Stat Calculations > 3 : Linear Regression (mx+b)**. Select *one* from the **X List** drop-box, *two* from the **Y List** drop-box, then press enter .

We can see that $r \approx 0.998$, and the line of best fit is $y \approx 2.54x + 2.71$.



To graph the line of best fit, press ctrl ◄ to return to the scatter diagram, press menu , then select **4 : Analyze > 6 : Regression > 1 : Show Linear (mx+b)**. The line of best fit will appear.

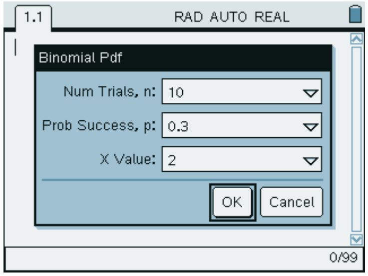


F PROBABILITY

BINOMIAL PROBABILITIES

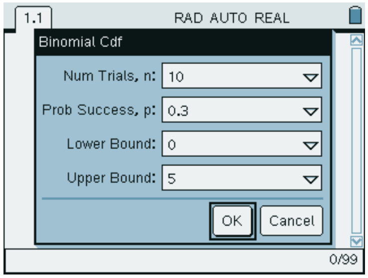
To find $\mathrm{P}(X = 2)$ for $X \sim \mathrm{B}(10, 0.3)$, press ctrl I **1** to open the Calculator application. Press menu then select
5 : Probability > 5 : Distributions > D : Binomial Pdf ... .

Press 10 tab 0.3 tab 2 tab enter . The result is 0.233.



To find $\mathrm{P}(X \leqslant 5)$ for $X \sim \mathrm{B}(10, 0.3)$, press menu from the Calculator application and select **5 : Probability > 5 : Distributions > E : Binomial Cdf ...** .

Press 10 tab 0.3 tab 0 tab 5 tab enter . The result is 0.953.

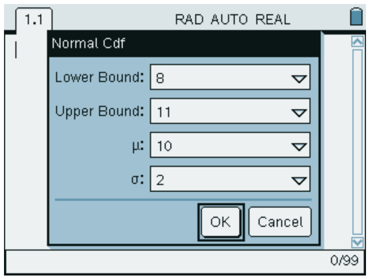


NORMAL PROBABILITIES

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

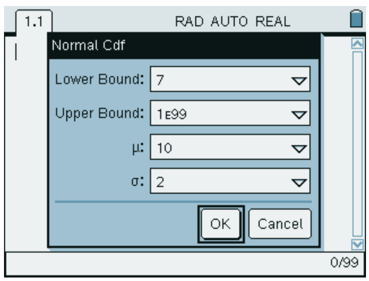
To find $\mathrm{P}(8 \leqslant X \leqslant 11)$, press menu from the Calculator application and select
5 : Probability > 5 : Distributions > 2 : Normal Cdf ... .

Press 8 tab 11 tab 10 tab 2 tab enter . The result is 0.533.



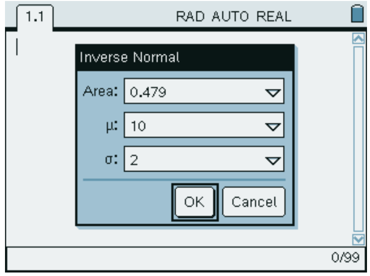
To find $\mathrm{P}(X \geqslant 7)$, press menu from the Calculator application and select
5 : Probability > 5 : Distributions > 2 : Normal Cdf ... .

Set up the screen as shown, and select **OK**. The result is 0.933.



To find a such that $P(X \leqslant a) = 0.479$, press menu from the Calculator application and select **5 : Probability** > **5 : Distributions** > **3 : Inverse Normal ...** .

Press 0.479 tab 10 tab 2 tab enter . The solution is $a \approx 9.89$.



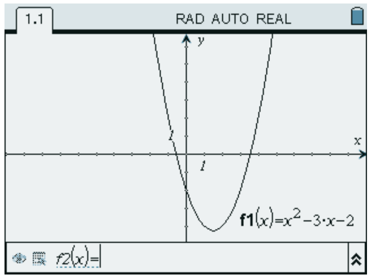
G WORKING WITH FUNCTIONS

GRAPHING FUNCTIONS

Pressing ctrl I **2 : Graphs** opens the Graphing application, where you can graph functions.

To graph the function $y = x^2 - 3x - 2$, press X x^2 − 3 X − 2 enter .

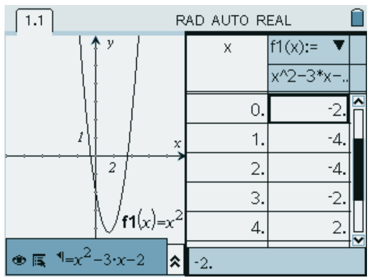
You can delete the functions you have graphed by pressing menu , then selecting **1 : Actions** > **5 : Delete all**.



To view a table of values for the function, press ctrl T .

The page splits into two, with the graph on one side and the table of values on the other side.

You can delete the table by pressing ctrl ⌂ , then selecting **5 : Page Layout** > **5 : Delete Application**.



ADJUSTING THE VIEWING WINDOW

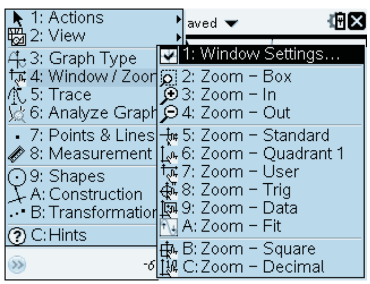
When graphing functions it is important that you are able to view all the important features of the graph. As a general rule it is best to start with a large viewing window to make sure all the features of the graph are visible. You can then make the window smaller if necessary.

To adjust the viewing window, press menu then select **4 : Window/Zoom** . The most useful options are:

1 : Window Settings : With this option you can set the minimum and maximum values for the x and y axes manually.

5 : Zoom-Standard : This option returns the viewing window to the default setting of $-10 \leqslant x \leqslant 10$, $-\frac{20}{3} \leqslant y \leqslant \frac{20}{3}$.

A : Zoom-Fit : This option scales the y-axis to fit the minimum and maximum values of the displayed graph within the current x-axis range.



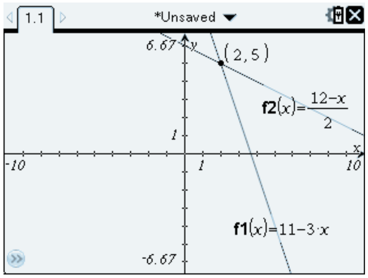
Pressing ctrl G removes the function entry line, allowing you to use the full screen to view the graph. Press ctrl G again to bring the function entry line back.

FINDING POINTS OF INTERSECTION

To find the intersection point of $y = 11 - 3x$ and $y = \frac{12 - x}{2}$, store $y = 11 - 3x$ into $f_1(x)$ and $y = \frac{12 - x}{2}$ into $f_2(x)$.

Press menu, then select **6 : Analyze Graph > 4 : Intersection**.

Move the cursor to the left of the intersection point and press enter, then move the cursor to the other side and press enter. The intersection point (2, 5) is displayed.

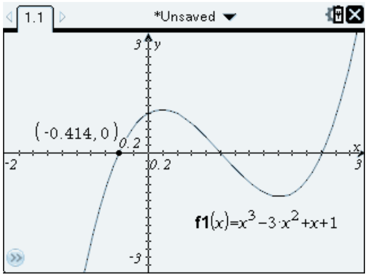


FINDING x-INTERCEPTS

To find the x-intercepts of $f(x) = x^3 - 3x^2 + x + 1$, store $x^3 - 3x^2 + x + 1$ into $f_1(x)$.

To find the x-intercepts, press menu, then select **6 : Analyze Graph > 1 : Zero**. Place the lower and upper bounds either side of the first x-intercept.

The first x-intercept $x \approx -0.414$ is given. Repeat this process to find the remaining x-intercepts $x = 1$ and $x \approx 2.414$.

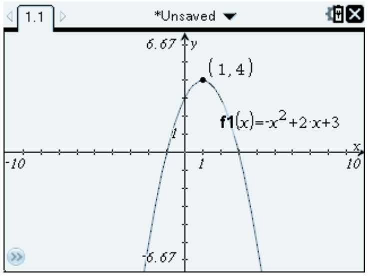


TURNING POINTS

To find the turning point or vertex of $y = -x^2 + 2x + 3$, store $-x^2 + 2x + 3$ into $f_1(x)$.

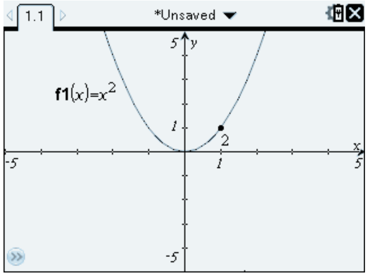
From the graph, the vertex is clearly a maximum, so press menu, then select **6 : Analyze Graph > 3 : Maximum**.

Place the lower and upper bounds either side of the vertex. The vertex is at (1, 4).

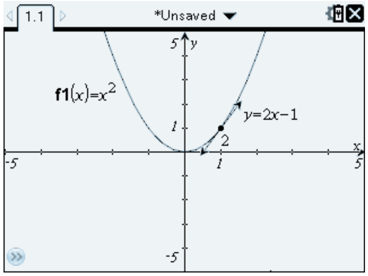


THE TANGENT TO A FUNCTION

To find the gradient of the tangent to $y = x^2$ when $x = 1$, we first draw the graph of $y = x^2$. Press menu, then select **6 : Analyze Graph** > **5 : dy/dx**. Press (1 enter. The tangent has a gradient of 2 at this point.



Press menu, then select **7 : Points & Lines** > **7 : Tangent**. Move the cursor towards the point (1, 1) until the phrase *point on* appears, then press enter to draw the tangent.

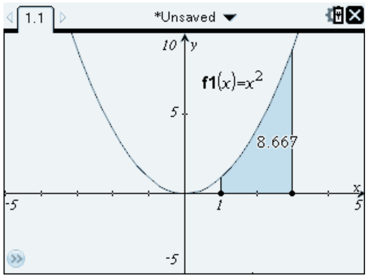


To find the equation of the tangent, press esc to exit the tangent command, and move the cursor over the tangent until the word *line* appears. Press ctrl menu and select **7 : Coordinates and Equations**. The tangent has equation $y = 2x - 1$.

DEFINITE INTEGRALS

To calculate $\int_1^3 x^2\,dx$, we first draw a graph of $y = x^2$. Press menu, then select **6 : Analyze Graph** > **6 : Integral**. Press (1 enter to specify the lower bound, then (3 enter to specify the upper bound.

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



Alternatively, you can press menu from the Calculator application, select **4 : Calculus** > **2 : Numerical Integral**, then set up the screen as shown.