CAMBRIDGE TECHNOLOGY IN MATHS

Year 11

TI-Nspire user guide

CONTENTS

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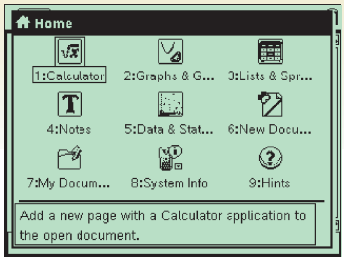
APPENDIX A

Computer Algebra System (TI-Nspire)

A.1 Introduction to the TI-Nspire

The Home screen

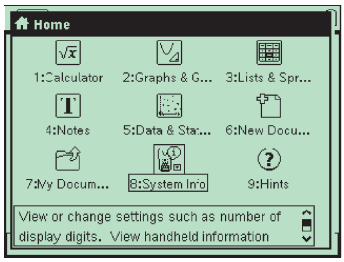
When pressing the home key ( ) you always arrive at the Home screen. From here you can

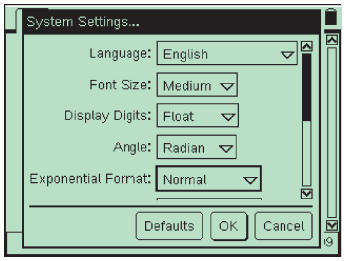


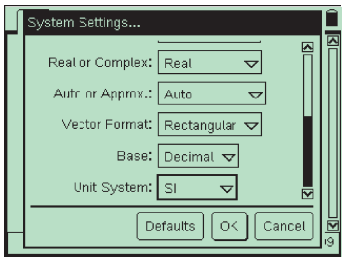
1. Open/insert a Calculator application.
2. Open/insert a Graphs & Geometry application.
3. Open/insert a Lists & Spreadsheet application.
4. Open/insert a Notes application.
5. Open/insert a Data & Statistics application.
6. Open a New Document.
7. Go to the My Documents folder.
8. View the System Information and change the settings.
9. Get Hints on how to use the calculator.

System settings

To change the system settings go to the Home screen ( ) and select **System Settings** from the System Info menu ( ). Use the **tab** key ( ) to move between the different categories and use the **selection tool** ( ) to open a category. Use the **up arrow** ( ) or **down arrow** ( ) on the NavPad to move between the different options within a category. When finished, press **enter** ( ) to confirm. The settings shown below are the recommended settings for Mathematical Methods.

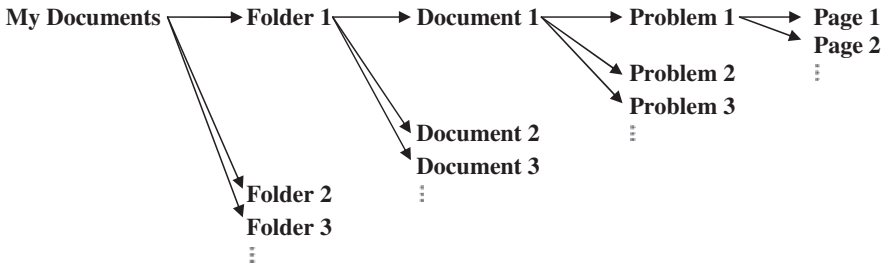




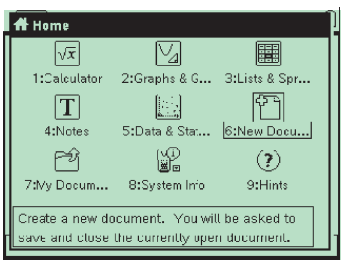


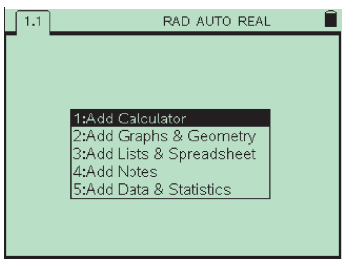
Documents—organisation and navigation

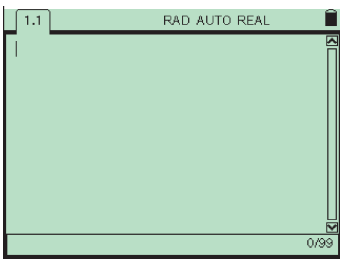
The calculator allows you to save documents very much like on a computer. Documents are saved in the **My Documents** folder (⌂ 7). In this folder you can create your own **folders**. Each **document** can contain a number of **problems**, and each problem can contain a number of **pages**.



Select **New Document** (⌂ 6) from the home screen to create a new document. The calculator will ask you whether you want to open a Calculator application, a Graphs & Geometry application, a Lists & Spreadsheet application, a Notes application or a Data & Statistics application for the first page of this document. On most occasions you will want to open a **Calculator** application (1) as shown below.



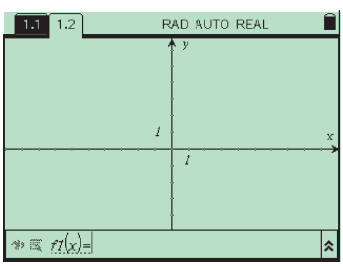


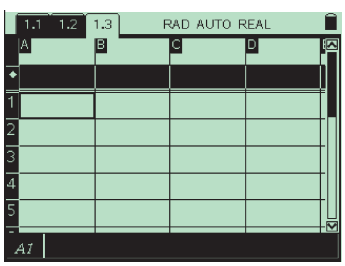


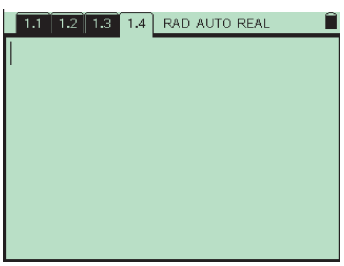
The numbering 1.1 in the top left-hand corner indicates that you are in problem 1, on page 1. In general, the numbering *m.n* indicates problem *m*, on page *n*.

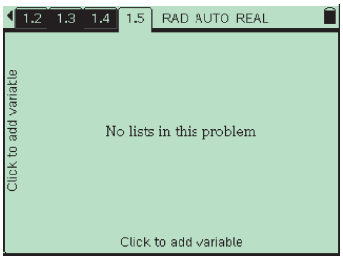
There are three ways of adding another page (application) to the document. Either go to the home screen (⌂) and select the appropriate application, or insert (ctrl 4 or ctrl I) that application.

To insert an additional four pages, each one with one of the remaining four applications, press ⌂ 2 ⌂ 3 ⌂ 4 ⌂ 5. The four pages will look as shown below.





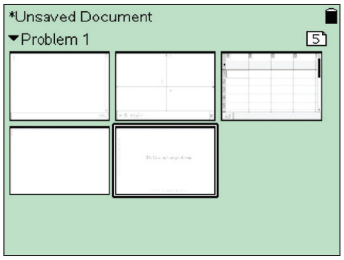




Notice how the new pages have numbers 1.2, 1.3, 1.4 and 1.5 as explained above.

In Mathematical Methods we will mainly be using the Calculator application, the Graphs & Geometry application and the Lists & Spreadsheet application.

Navigation within a document can be done in two ways. One way is to press (ctrl) ◀ to move to the page on the left; and press (ctrl) ▶ to move to the page on the right. Another way is to get an overview of the document by pressing (ctrl) ▲ and navigate using the **arrows** (◀ ▶ ▲ ▼) on the NavPad. Press **enter** ((enter)) to select a highlighted page. For the five pages above, the overview will look as shown below.



From this view it is easy to **insert** ((⌂)) a new page (after a highlighted page) and **delete** ((clear)) a highlighted page.

To get back to the individual page view either press **enter** ((enter)) on a highlighted page or press (ctrl) ▼.

There is also the opportunity to add another problem ((ctrl) 🔧 (4)) to a document. Within this problem new pages can be inserted as explained above.

However, despite all the opportunities for sophisticated organisation of documents, most students of Mathematical Methods can, to begin with, create one document, with one Calculator application and one Graphs & Geometry application, and use that for all their calculations and graphing.

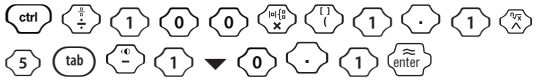
A.2 Using the Calculator application

The Calculator application works like a basic calculator and it is here that you will complete most of your arithmetical calculations.

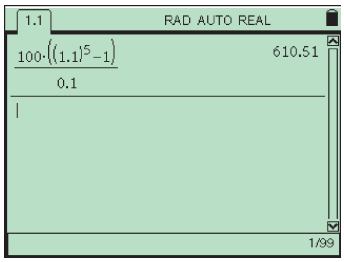
Entering and editing expressions

The following example shows how to enter, evaluate and edit the expression $\frac{100\left(1.1^5-1\right)}{0.1}$.

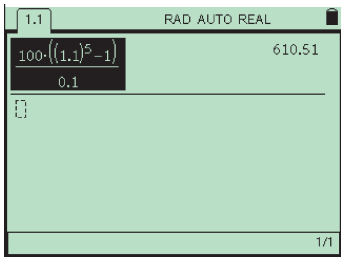
To enter and evaluate the expression $\frac{100\left(1.1^5-1\right)}{0.1}$, press the following keys:



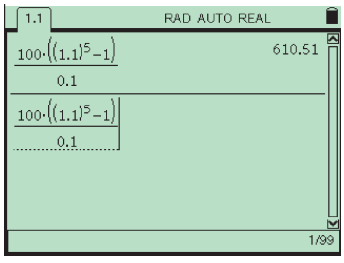
Notice the use of the division template and that each opening bracket is automatically followed by a closing bracket.



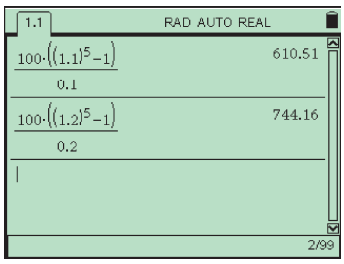
To enter and evaluate the expression $\frac{100\left(1.2^5-1\right)}{0.2}$, notice the similarity with the one we entered above and move upwards by pressing the **up arrow** (▲) twice until the previous expression is highlighted as shown.



Press **enter** (enter) to paste this expression in the new line as shown.



Use the **arrows** (◀ ▶ ▲ ▼) on the NavPad to move into the expression and use the **delete** key (clear) to delete the two 1s before replacing them by 2s. Press **enter** (enter) to evaluate this new expression.



Rather than copy and paste an entire expression as explained above, it is also possible to **copy** and **paste** a part of an expression. To do this, move to the expression as explained above, move into it using the **arrows** (◀ ▶ ▲ ▼) on the NavPad and select the part you want to copy by pressing and holding down the CAPS key while using the **arrows** (◀ ▶ ▲ ▼) on the NavPad to select the part you want to copy. Press **enter** (enter) to paste this selection in the new line.

The calculator can also perform more complicated mathematical calculations, all of which can be found in the **menu** (menu). The most frequently used in Mathematical Methods are explained below, in order of appearance.

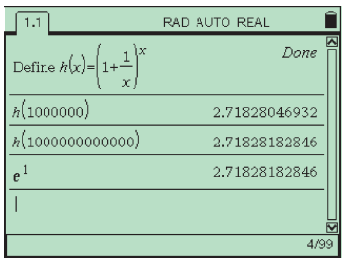
Operations in the Actions menu

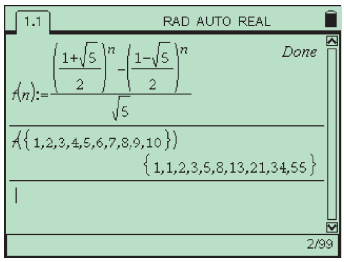
1:Define

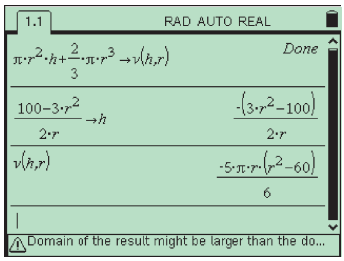
This command is used for defining functions of one or more variables.

There are two other ways of defining functions; either use the notation := (: =) or use **store** (ctrl sto→ var).

The following screens illustrate their use.







4:Clear a-z

This command is used to clear the one-character variables a–z.

It is highly recommended that you use mainly one-character variables and use this command frequently to clear these variables.

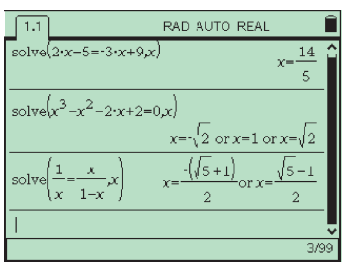
Operations in the Algebra menu

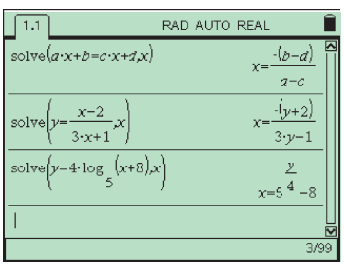
1:Solve( )

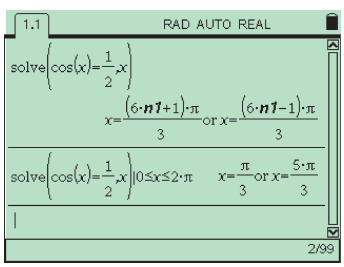
This command is used to solve equations, simultaneous equations and some inequalities.

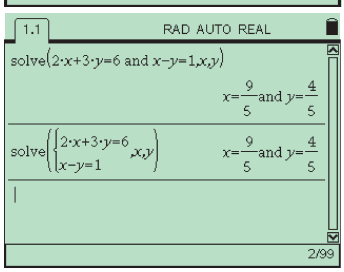
An approximate (decimal) answer can be obtained by pressing ctrl enter or by including a decimal number in the expression.

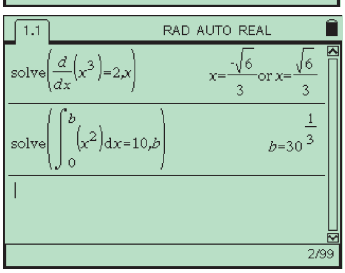
The following screens illustrate its use.

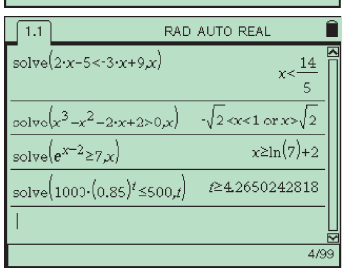










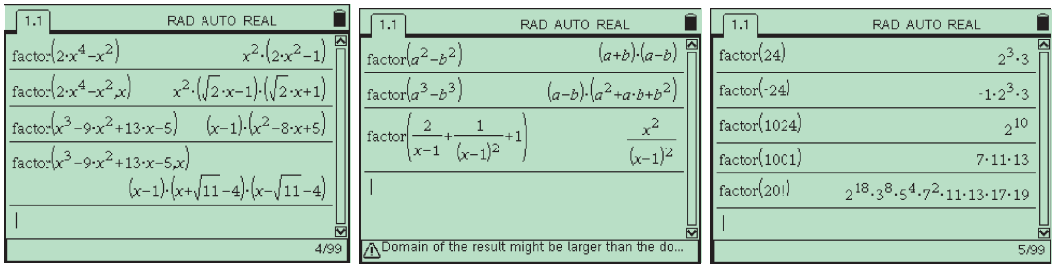


2:Factor( )

This command is used for factorisation.

Factorisation over the rational numbers is obtained by not specifying the variable, whereas factorisation over the real numbers is obtained by specifying the variable.

The following screens illustrate its use.

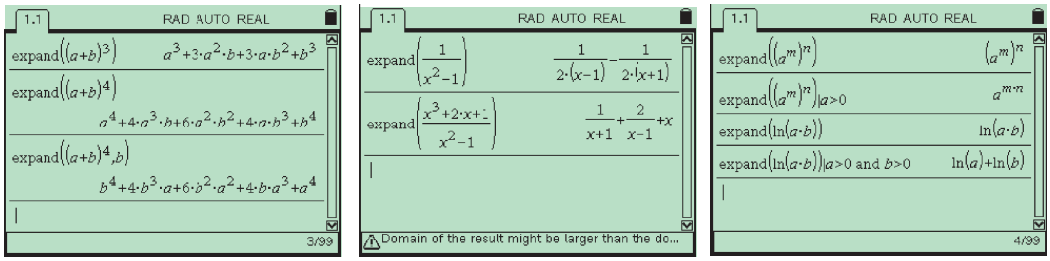


3:Expand( )

This command is used for expansion of expressions.

By specifying the variable, the expanded expression will be ordered in decreasing powers of that variable. Symbolic expressions can only be expanded for an appropriate domain.

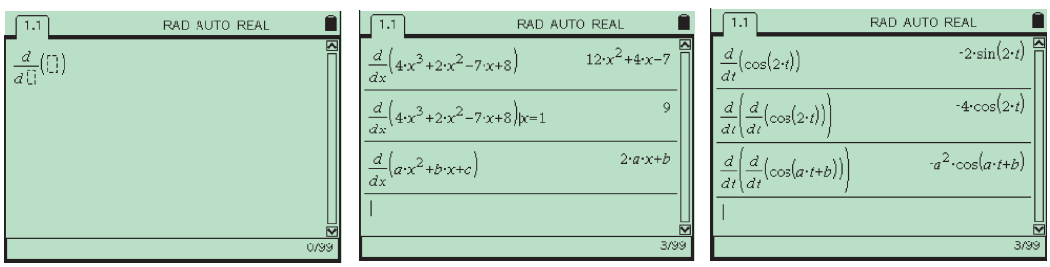
The following screens illustrate its use.



Operations in the Calculus menu

1:Derivative

This operation is used to differentiate expressions. The following screens illustrate its use.

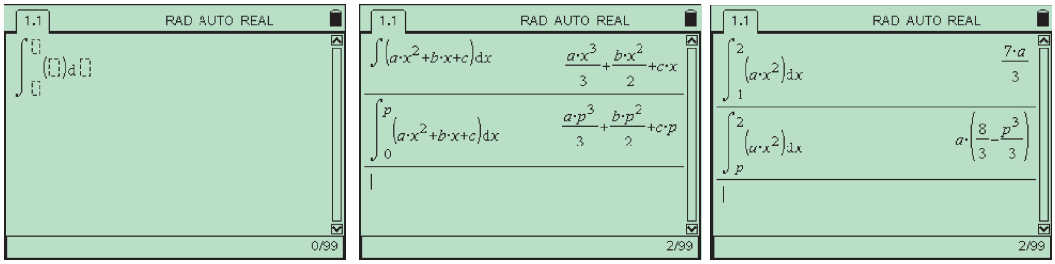


The differentiation template can also be accessed from the templates menu (ctrl).

In the templates menu there is also a template for the *n*th derivative.

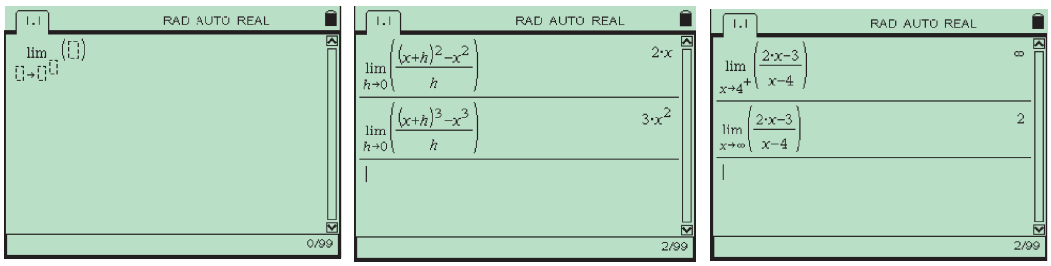
2:Integral

This operation is used to integrate expressions. The following screens illustrate its use.



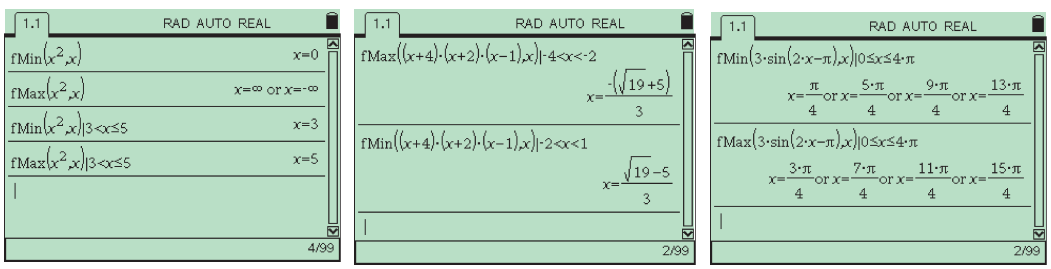
3:Limit

This operation is used to find limits of expressions. The following screens illustrate its use.



6:Function Minimum and 7:Function Maximum

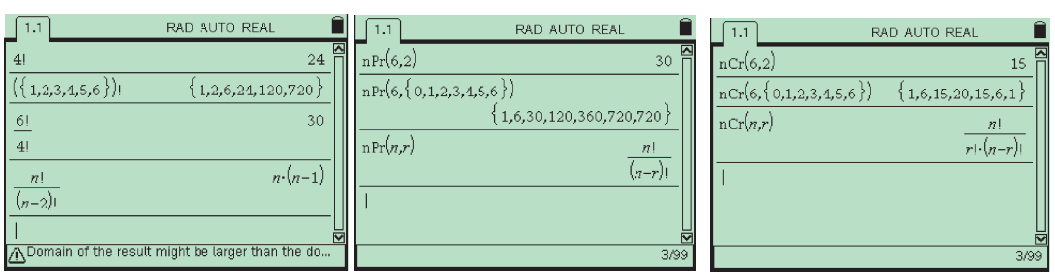
These operations return the value for which the minimum or maximum value (or the greatest lower bound) of a function occurs. The following screens illustrate their use.



Operations in the Probability menu

1:Factorial (!), 2:Permutations and 3:Combinations

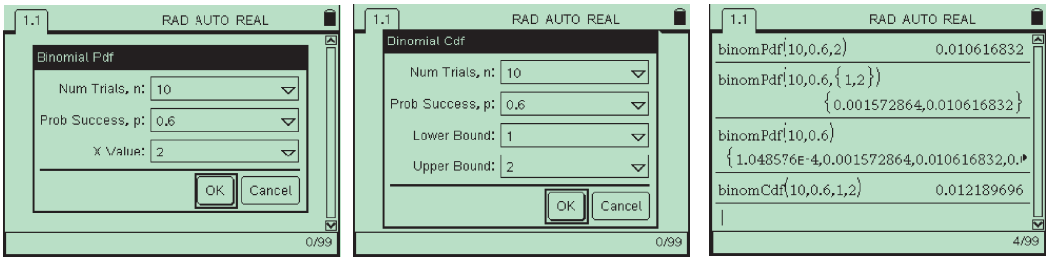
These functions are used to solve counting method problems. The following screens illustrate their use.



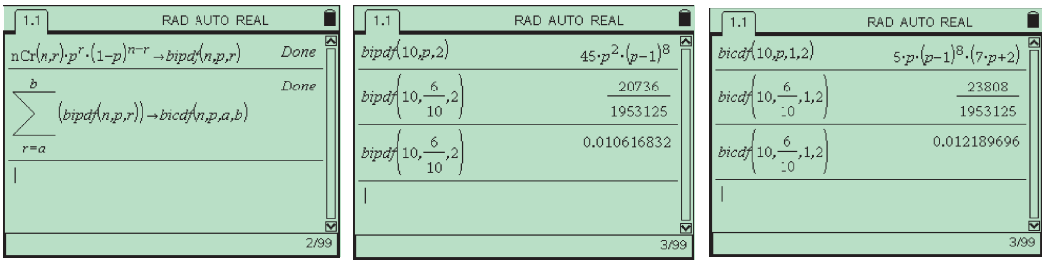
5:Distributions

This menu contains a list of distributions. For us, especially the binomial distribution and the normal distribution are of interest.

For calculations using the binomial distribution we use either **D:Binomial Pdf** (binomial probability distribution function) or **E:Binomial Cdf** (binomial cumulative distribution function). Use the **tab** key (tab) to move between the number fields. The following screens illustrate their use.



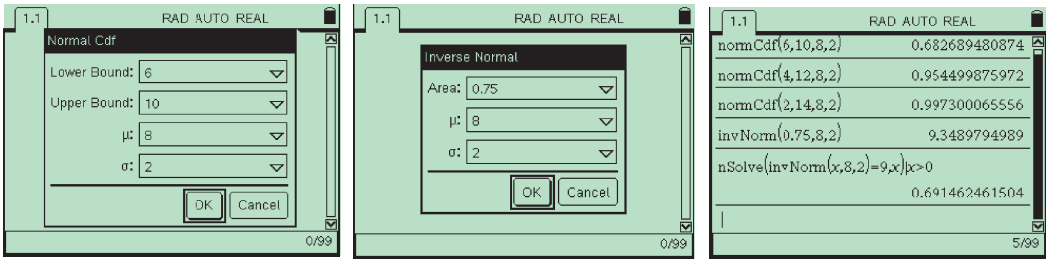
Unfortunately, these functions can only return an approximate (decimal) answer, so to obtain an exact answer consider defining the functions *bipdf* and *bicdf* as shown below.



For calculations using the normal distribution we use either **2:Normal Cdf** (normal cumulative distribution function) or **3:Inverse Normal**.

When using these functions you can solve for any of the variables using **nSolve( )** (Numerical Solve) and an appropriate domain.

The following screens illustrate their use.

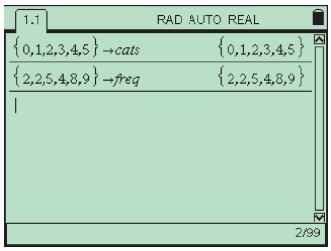


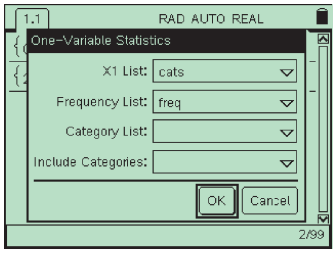
Operations in the Statistics menu

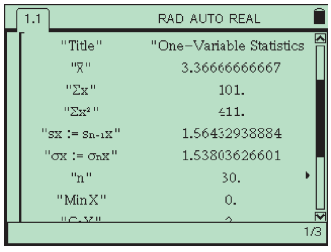
1:Stat Calculations

This menu contains a list of operations on data.

The following screens illustrate the use of the **1:One-Variable Statistics** command.

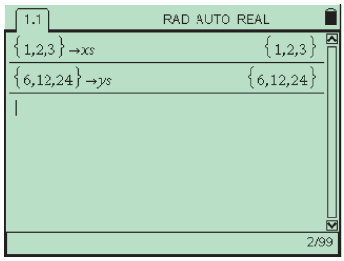


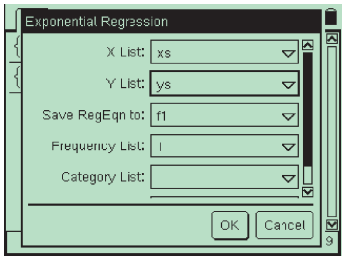


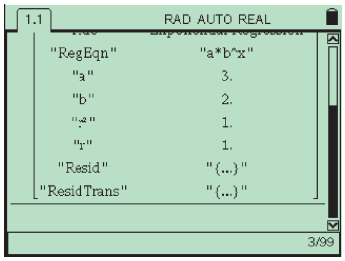


Note that the commands to find the *mean*, *median*, (population) *variance* and (population) *standard deviation* of a list of numbers are available from the **List Math** menu (menu 6 3).

The following screens illustrate the use of the **A:Exponential Regression** command. The last screen shows that the exponential function going through the points (1, 6), (2, 12) and (3, 24) has equation $f(x) = 3 \times 2^x$. This is found through the menus 6: Statistics, 1: Stat Calculations.



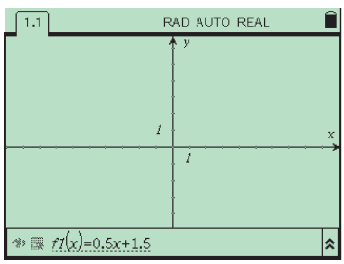


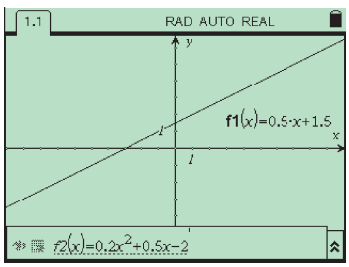


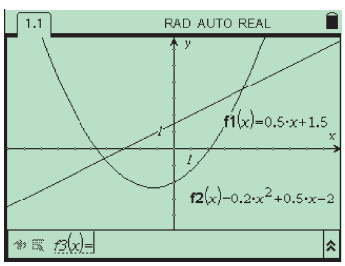
A.3 Using the Graphs & Geometry application

Plotting functions

To graph a function simply type the expression (in terms of x) in the entry line for one of the predefined functions $f1(x) - f99(x)$ followed by **enter** as shown in the screens below.

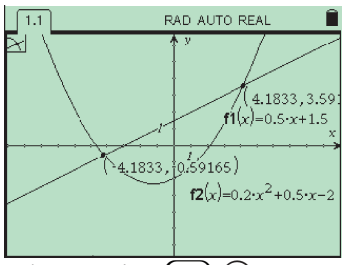






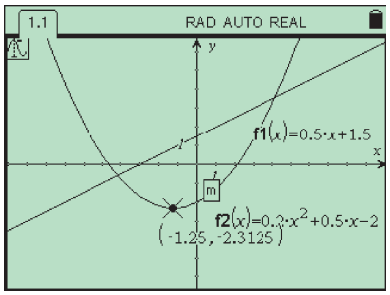
Finding intersection points

Intersection Points (menu 6 3) is used to display the approximate (decimal) coordinates of the intersection point(s). Select each of the two graphs (or a graph and an axes) using the **arrow keys** (◀▶ ▲ ▼) followed by **enter**. Press **escape** (esc) to exit the command. On the screen to the right, Intersection Point(s) has been used to find the intersection points of f1 and f2. Notice how you can **hide/show the entry line** by pressing ctrl G.



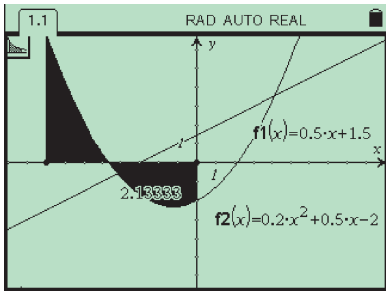
Finding zero(s) and local minimum(s)/maximum(s)

Graph Trace (menu 5 1) is used to display the approximate (decimal) coordinates of points on the graph. The tracing point (×) can either be moved using the **arrow keys** (◄►) or by typing a specific x-value followed by **enter**. When trace reaches a zero it displays [z], when it reaches a local minimum it displays [m] and [M] with a local maximum. Press **escape** (esc) to exit the command. On the screen to the right, Graph Trace has been used to find the turning point of f2.



Finding integrals

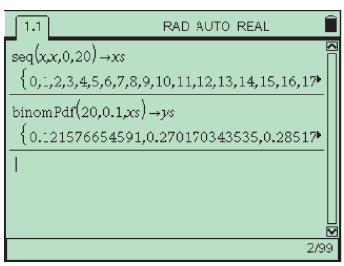
Integral (menu 7 5) is used to display the approximate (decimal) integral. Select the graph using the **arrow keys** (◄►) followed by **enter**. Then type the lower limit, followed by **enter**, and type the upper limit, followed by **enter**. Press **escape** (esc) to exit the command. On the screen to the right, Integral has been used to find the integral of f2 between –15 and 0.

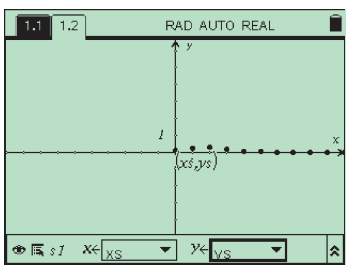


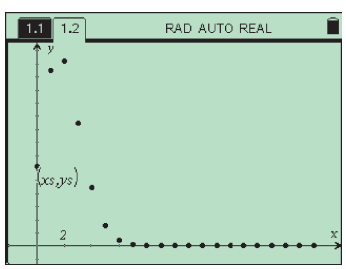
Plotting probability distributions

To graph a (discrete) binomial distribution, first create a sequence of the outcomes in a Calculator application and use the binomial probability distribution function command **binomPdf**(n,p,x) on that list. In a Graphs & Geometry application select **Scatter Plot** (menu 2 4) and define the x-values to be the sequence of the outcomes and the y-values to be the corresponding binomial probability distribution function values. Finally, select **Zoom—Data** (menu 4 9) to get a window that best fits the data.

The following screens illustrate how to graph the binomial distribution with parameters $n = 20$ and $p = 0.1$.

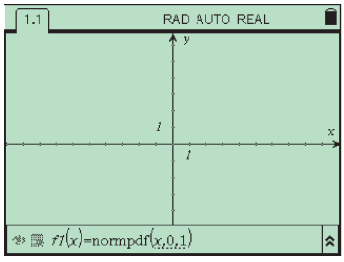


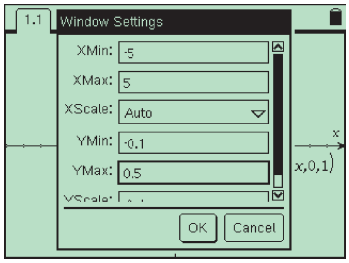


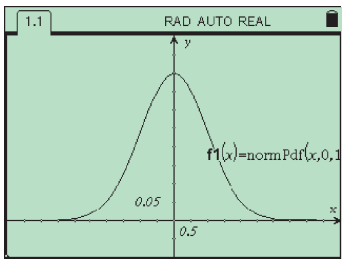


To graph a (continuous) normal distribution curve we use the normal probability distribution function command **normPdf**(x,μ,σ) from the catalog (ctrl 1 N).

The following screens illustrate how to graph the standard normal distribution in the **window** (menu 4 1) $-5 \le x \le 5$ and $-0.1 \le y \le 1$.







A.4 Using the Lists & Spreadsheet application

The Spreadsheet is in many ways similar to a Microsoft Excel © spreadsheet. Cells can be filled down, sorted etc., and it will handle both absolute and relative references.

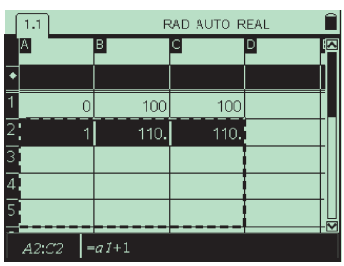
Absolute and relative references

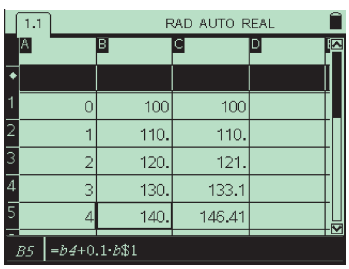
Simple interest and compound interest are here used to illustrate the use of absolute and relative cell references.

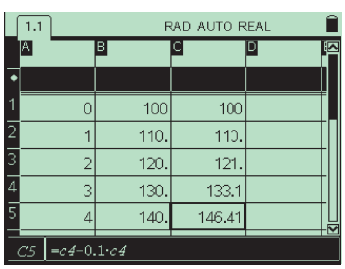
Enter 0 in cell A1, 100 in cell B1 and 100 in cell C1. Use the **arrows** (◀ ▶ ▲ ▼) on the NavPad to move between cells. Enter = a1 + 1 in cell A2, = b1 + 0.1 × b$1 in cell B2 and = C1 + 0.1 × C1 in cell C2. The $ symbol is found by pressing ctrl ".

Highlight the cells A2, B2 and C2 using CAPS and the **arrows** (◀ ▶ ▲ ▼) on the NavPad, and use **Fill Down** (menu 3 3) and the **down arrow key** (▼), followed by **enter**, to generate the numbers in the next three rows.

The following screens illustrate the process.







The resulting numbers are the value of 100 dollars invested at 10% p.a. simple interest (column B) and 10% p.a. compounded interest (column C) over the next 4 years.

Note the important difference in the formulas in cells B5 (= B4 + 0.1 × B$1) and C5 (= C4 + 0.1 × C4). In the B-column, the use of the $ symbol in front of 1 in cell B2 fixed this value such that when filled down it did not change, still adding 10% of the value in cell B1. This is an example of an *absolute* reference. In the C-column, the cell references are slightly different, always adding 10% of the value in the previous cell. This is an example of a *relative* reference.

A.5 Dynamic geometry

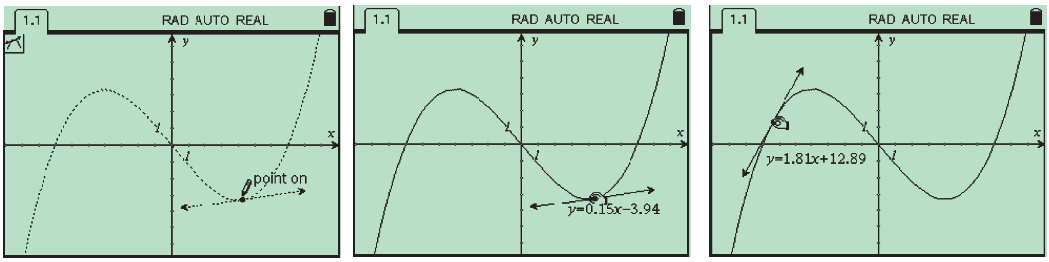
The calculator can dynamically change objects and corresponding calculations and thus provide ample opportunities for teachers and students to dynamically illustrate mathematical concepts and ideas.

Example 1—a moving tangent

This example shows how the calculator can be used to dynamically illustrate the concept of *instantaneous rate of change* as the gradient of the tangent.

1. Open a Graphs & Geometry application (⌂ 2).
2. Type the expression of the function $f(x) = x(x - 7)(x + 7)/40$ in the entry line.
3. **Hide the entry line** (ctrl G).
4. Hide the function label (menu 1 3).
5. Place a **tangent** (menu 6 7) at the point on the graph using the NavPad.
6. **Show the equation** of the tangent (menu 1 7) (double-click).
7. Move the open hand (✋) to the point. Press and hold down ⬚ when the point is flashing in the hand. The hand is now closed (✊).
8. Move the point using the NavPad to dynamically illustrate the gradient of the curve.

The following screens show the tangent placed at a point on the curve and the point moved along the curve.

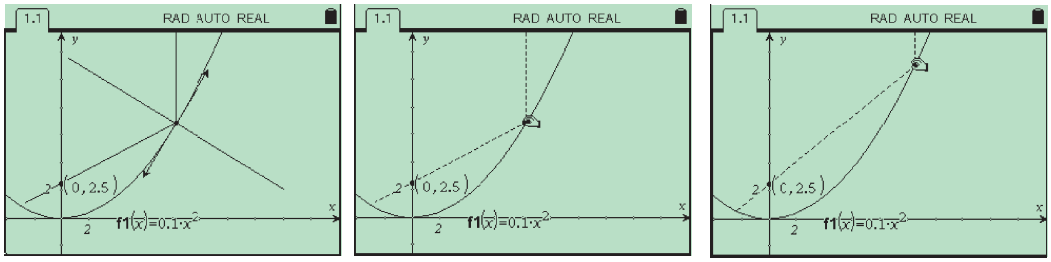


Example 2—a parabola with a point

This example shows how the calculator can be used to dynamically illustrate why parabolas play an important part in the design of torches and satellite dishes.

1. Open a Graphs & Geometry application (⌂ 2).
2. Type in the expression of the quadratic $f(x) = 0.1x^2$ in the entry line.
3. **Hide the entry line** (ctrl G).
4. Select the **first quadrant** window (menu 4 6).
5. Place a **ray** (menu 6 6) on a point on the graph, pointing upwards, parallel to the y-axis. Press ⇧ to move in increments of 15°.
6. Place a **tangent** (menu 6 7) at the point on the graph using the NavPad.
7. Construct the **perpendicular** line (menu 9 1) to the tangent at this point.
8. **Reflect** (menu A 2) the ray in this line. Select the line of reflection first.
9. Place a **point of intersection** (menu 6 3) between the y-axis and this new ray.
10. **Show the coordinates** (menu 1 7) of this point (double-click).
11. **Hide** (menu 1 3) the tangent and the perpendicular line.
12. Change the **attribute** (menu 1 4) of the ray and the reflected ray to **dashed line style**.
13. Move the open hand (✋) to the point. Press and hold down ⬚ when the point is flashing in the hand. The hand is now closed (✊).
14. Move the point using the NavPad to dynamically illustrate the unchanging *focal point*.

The following screens show the ray, tangent and reflected ray at a point on the curve and the point moved along the curve.



A.6 Learning more

There is much to be learned from reading the manual that comes with the calculator, but there are also some highly recommended free online tutorials on the internet, including:

- **Atomic Learning TI-Nspire tutorials**
  http://movies.atomiclearning.com/k12/ti_nspire/
- **T^3 Online Course — Getting Started with TI-Nspire™**
  http://education.ti.com/educationportal/sites/US/sectionHome/pd_onlinetinspire_free.html