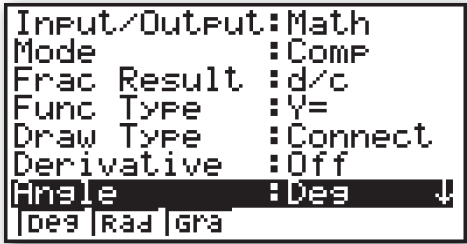


1 Useful hints

Setting the angle mode

When you reset your calculator (or change batteries) the default angle mode is radians. If you are working in degrees you will need to change this.

How you do it...

Notes	You should press	You will see
To get to the correct menu	SHIFT MENU (SETUP)	
To select degree mode	▼ ▼ ▼ ▼ F1 (Deg)	

Redoing calculations

If you made a mistake with the last line you typed in, press the left key (◀).

The previous line is returned and you can edit it before pressing **EXE** again.

If you know you are going to be using the similar calculations repeatedly you use a copy and paste function.

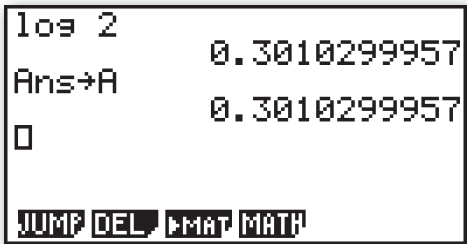
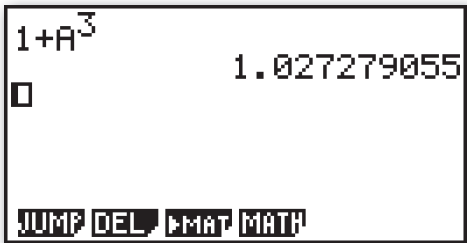
* These instructions were written based on the CASIO model fx-9860G SD and might not be true for other models. If in doubt refer to your calculator's manual.

Storing answers

The calculator can store numbers in its memory and use them in later calculations.

For example, to store $\log 2$ and use it in a later calculation:

How you do it...

Notes	You should press	You will see
Perform the calculation	log 2 EXE	
Store in the variable 'A'	→ ALPHA X,θ,T (A) EXE	
To use this in calculating $1 + (\log 2)^3$	1 + ALPHA X,θ,T (A) ^ 3 EXE	

Working with fractions

Pressing the **$\frac{a}{b}$** button allows a fraction to be entered. Pressing **SHIFT** **$\frac{a}{b}$** allows a mixed number to be entered. Pressing the **F \leftrightarrow D** button changes between fractions and decimals. Decimals are only recognised if their denominator is less than 1000.

2 Viewing graphs

Inputting a function


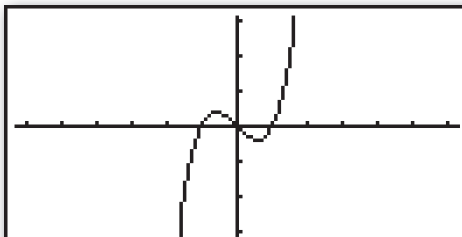
You will need...

- A function in the form $y = f(x)$

In our example...

- $y = x^3 - x$

How you do it...

Notes	You should press	You will see
To get to the correct menu (GRAPH)	MENU 5	
Input the function into Y1	X,θ,T ^ 3 - X,θ,T EXE	
View the graph	F6 (DRAW)	

Setting which part of the graph you see

Whilst viewing the graph it is possible to zoom in and out (using the ZOOM menu: **SHIFT** **F2** (ZOOM)) but it is often a better idea to explicitly select the viewing window (and selecting the min and max values of x and y) by pressing **F3** (V-Window).

* These instructions were written based on the CASIO model fx-9860G SD and might not be true for other models. If in doubt refer to your calculator's manual.

3 Finding some important functions

Finding $\binom{n}{r}$

For example: to find $\binom{7}{3}$.

How you do it...

Notes	You should press	You will see
To get to the correct menu	OPTN F6 (>) F3 (Prob) 7 F3 (nCr) 3 EXE	

Finding $x!$

For example: to find $9!$.

How you do it...

Notes	You should press	You will see
To get to the correct menu	OPTN F6 (>) F3 (Prob) 9 F1 (x!) EXE	

Finding $|x|$

For example: to find $|-5|$.

How you do it...

Notes	You should press	You will see
To get to the correct menu	OPTN F6 (>) F4 (Num) F1 (Abs) (-) 5 EXE	

* These instructions were written based on the CASIO model fx-9860G SD and might not be true for other models. If in doubt refer to your calculator's manual.

4 Analysing graphs

You will need...

- A graph to analyse (see Calculator skills 2 for how to input this)
- An x -value where you want to know the y -value
- A y -value where you want to know the x -value
- Which type of turning point you are interested in

In our example...

- $y = x^3 - x$
- $x = 2$
- $y = 0$
- A maximum point

How to find coordinates of a point given an x -value

How you do it...

Notes	You should press	You will see
When viewing a graph (see calculator skills 2 'Viewing graphs', if required)	SHIFT F5 (G-Solv) F6 (>) F1 (Y-Cal)	
Input the required x value	2 EXE	

What to write down...

When $x = 2$, $y = 6$ (from GDC).

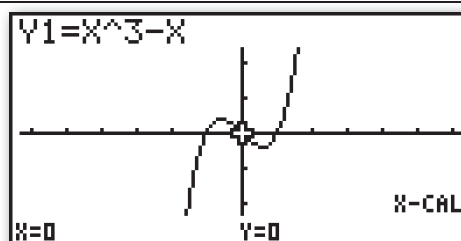
How to find coordinates of the points where $y = 0$ (zeros or roots)

How you do it...

Notes	You should press	You will see
When viewing a graph (see calculator skills 2 'Viewing graphs' if required)	SHIFT F5 (G-Solv) F6 (>) F2 (X-CAL)	
Input the required y value	0 EXE	

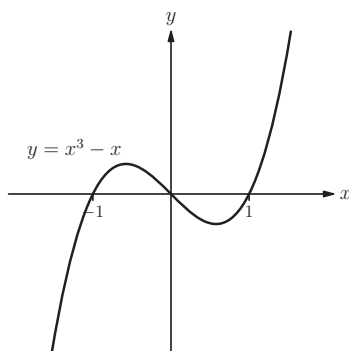
* These instructions were written based on the CASIO model fx-9860G SD and might not be true for other models. If in doubt refer to your calculator's manual.

Press across to go to the next solution, repeating as required



What to write down...

When $y = 0$, $x = -1, 0, 1$ (from GDC).



How to find the coordinates of a turning point

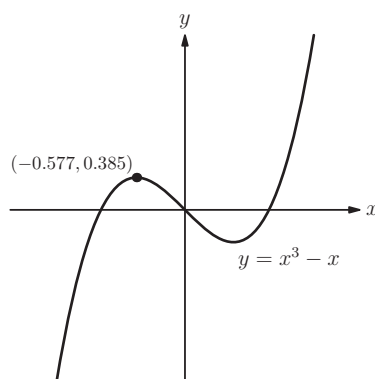
How you do it...

Notes	You should press	You will see
When viewing a graph	SHIFT F5 (G-SOLV) F2 (MAX)	
Press across to go to the next maximum, repeating as required		

If you want to find minimum points, use **F3** (MIN) instead.

What to write down...

Maximum occurs when $(-0.577, 0.385)$ (3SF from GDC).



5 Solving equations

Graphical solutions of equations

You will need...

- An equation to solve

In our example...

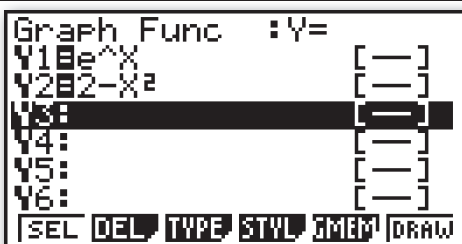
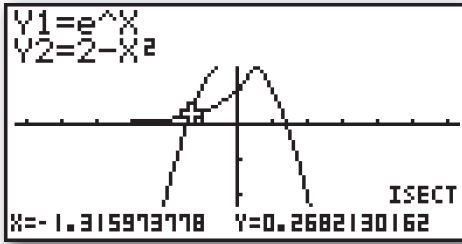
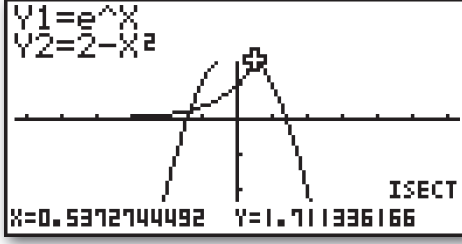
$$e^x = 2 - x^2$$

If you are trying to solve the equation $f(x) = g(x)$ plot the graphs

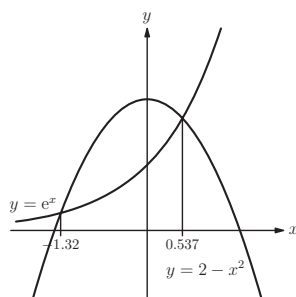
$$Y1 = f(x) \text{ and } Y2 = g(x)$$

The solution to the original equation is the x -coordinate of the intersection of these two graphs.

How you do it...

Notes	You should press	You will see
Go to the graphing menu (GRAPH)	MENU 5 (GRAPH)	
Put the left hand side into Y1	SHIFT In X,θ,T EXE	
Put the right hand side into Y2	2 = X,θ,T x² EXE	
Draw the graph and find where they intersect.	F6 (DRAW) SHIFT F5 (G-SLV) F5 (ISCT)	
Press across to get to the next solution.	▶	

What to write down...



From GDC $x = 0.537$ or $x = -1.32$ (3SF).

* These instructions were written based on the CASIO model fx-9860G SD and might not be true for other models. If in doubt refer to your calculator's manual.

Solving equations numerically

You will need...

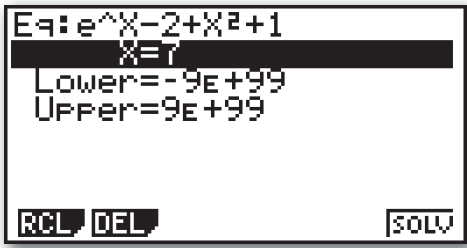
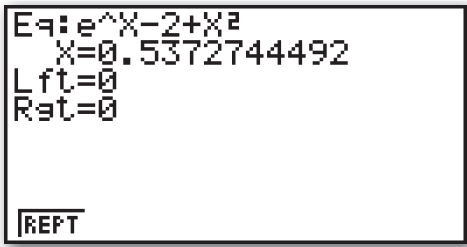
- An equation to solve, rearranged so that one side is zero
- An initial guess

In our example...

- $e^x - 2 + x^2 = 0$
- $x = 7$

The equation to be solved has to be rearranged so that one side is zero. This method starts from a 'guess' of the solution (which does not need to be particularly accurate) and it finds a single solution, usually the one closest to the guess. To find other solutions, other initial values must be tried.

How you do it...

Notes	You should press	You will see
Go to the equation solver (EQUA)	MENU ALPHA X,θ,T (EQUA) F3 (Solver)	
Input the non-zero side of the equation Enter the initial guess (you can also set the bounds or leave them at default)	SHIFT In X,θ,T - 2 + X,θ,T x² EXE 7 EXE	
Move the cursor up so the initial guess is highlighted, and solve	F6 (SOLV)	

What to write down...

From GDC $x = 0.537$ (3SF) is one solution to the equation.

6 Solving polynomial and simultaneous equations

Solutions of polynomial equations

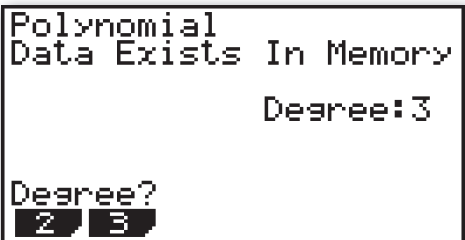
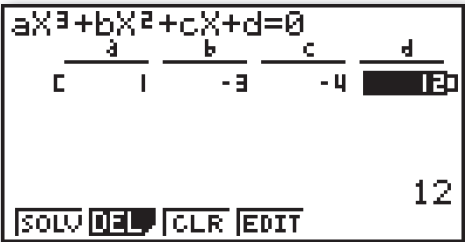
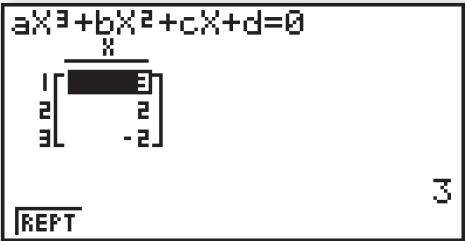
You will need...

- A polynomial equation in standard form
- The degree of the polynomial

In our example...

- $x^3 - 3x^2 - 4x + 12 = 0$
- 3 (cubic)

How you do it...

Notes	You should press	You will see
Go to the polynomial solver menu (via the EQUA menu)	MENU ALPHA X,θ,T (EQUA) F2 (POLY)	
Input the degree of the equation	F2 (3)	
Input the coefficients	1 EXE (-) 3 EXE (-) 4 EXE 1 2 EXE	
Solve the equation	F1 (SOLVE)	

What to write down...

From GDC $x = -2, 2$ or 3 .

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Solving linear simultaneous equations

You will need...

- Simultaneous equations with all the unknowns on one side
- The number of unknown variables

In our example...

- $x + 2y = 10$
 $2x - 3y = 13$
- 2

How you do it...

Notes	You should press	You will see
Go to the equation solver (EQUA in main menu)	MENU ALPHA X,θ,T (EQUA) F1 (SIML)	
Enter the number of unknown variables	F1 (2)	
Input all the coefficients	1 EXE 2 EXE 1 0 EXE 2 EXE (-) 3 EXE 1 3 EXE	
Solve	F1 (SOLV)	

What to write down...

From GDC $x = 8$ and $y = 1$.

Non-linear simultaneous equations

To solve two non-linear simultaneous equations we rearrange both equations into the form $y = f(x)$ and then plot the graphs and find where they intersect as described in Calculator skills 5. However, remember that now you need to give both the x - and the y -coordinates.

7 Functions

Sketching graphs of composite functions

You will need...

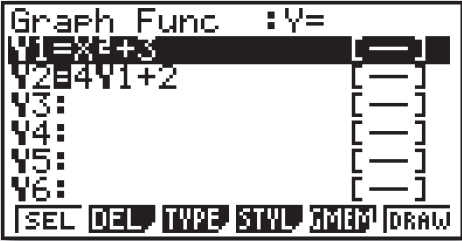
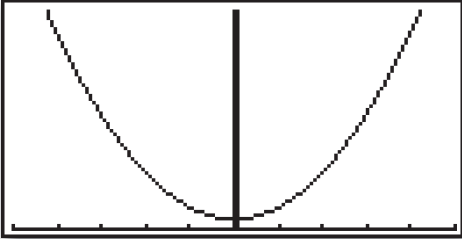
- An inner function
- An outer function

This will sketch the graph of $g(f(x)) = 4(x^2 + 3) + 2$.

In our example...

- $f(x) = x^2 + 3$
- $g(x) = 4x + 2$

How you do it...

Notes	You should press	You will see
Go to the GRAPH menu and put the inner function into Y1	MENU 5 (GRAPH) X,θ,T x² + 3 EXE	
Put the outer function into Y2 using Y1 as the argument.	4 F1 (Y) 1 + 2 EXE	
Unselect Y1 so it is not displayed	▲ ▲ F1 (SEL)	
Draw the graph	F6 (DRAW)	

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Sketching inverse functions

You will need...

- The function which you would like to invert

Note that this sketches the inverse *relation*.

In our example...

- $x^2 - 1$

How you do it...

Notes	You should press	You will see
Go to the GRAPH menu and put the function into Y1	MENU 5 (GRAPH) X,θ,T x² - 1 EXE	
Change the line style so that the the original function is thicker	▲ F4 F2 (THICK) EXIT	
Draw the function and sketch the inverse function	F6 (DRAW) SHIFT F4 (SKTCH) F4 (INV)	

You may find that the choice of scale makes the function look less like a reflection than it should. The SQR option in the Zoom menu [**SHIFT** **F2** (ZOOM) **F6** (>) **F2** (SQR)] sets the axes to be equivalent which can be useful when looking at inverse functions.

8 Complex numbers

Doing complex arithmetic

You will need...

- A calculation to perform

In our example...

$$\frac{3+i}{1+3i}$$

How you do it...

Notes	You should press	You will see
To change to complex mode	SHIFT MENU \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow \downarrow F2 (a + bi) EXE	
Go to the RUN menu. i is found using SHIFT 0 (On some older calculators you need to use OPTN F3 (CPLX) F1)	MENU 1 (RUN) (3 + SHIFT 0) ÷ (1 + 3 SHIFT 0) EXE	

You should write...

From GDC: $\frac{3+i}{1+3i} = 0.6 - 0.8i$

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Finding the modulus and argument of complex numbers

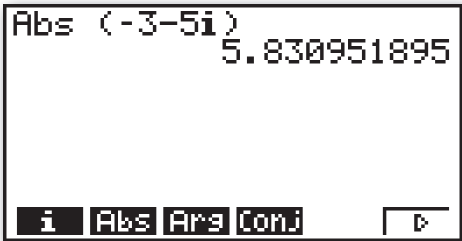
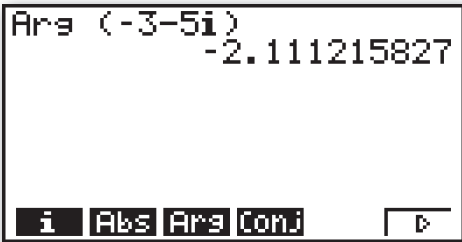
You will need...

- A complex number

In our example...

- $-3 - 5i$

How you do it...

Notes	You should press	You will see
Make sure you are working in radians (see Calculator skills 1). Access the CPLX menu	MENU 1 (RUN) OPTN F3 (CPLX)	
The modulus is called 'Abs'	F2 (Abs) ((←) 3 - 5 SHIFT 0) EXE	
To find the argument follow a similar procedure	F3 (Arg) ((←) 3 - 5 SHIFT 0) EXE	

You should write...

From GDC: $|-3 - 5i| = 5.83, \arg(-3 - 5i) = -2.11$ (3SF)

Converting from modulus-argument to Cartesian form

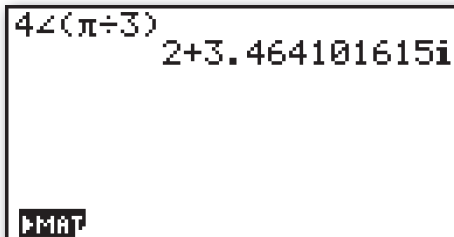
You will need...

- A complex number in modulus argument form

In our example...

- Modulus 4, argument $\frac{\pi}{3}$

How you do it...

Notes	You should press	You will see
Access the RUN Menu	MENU 1 (RUN)	
Use the \angle symbol to separate modulus and argument	4 SHIFT X,θ,T (SHIFT EXP ÷ 3) EXE	

This value can be used in calculations as normal.

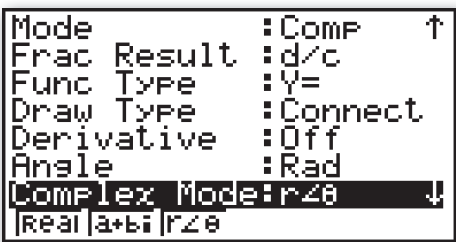
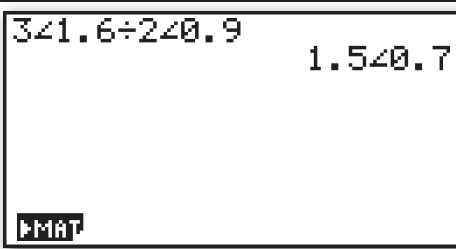
Doing calculations in modulus-argument form

You will need...

- A calculation to perform

In our example...

$$\frac{3e^{1.6i}}{2e^{0.9i}}$$

Notes	You should press	You will see
To change to modulus-argument mode	SHIFT MENU ▼ ▼ ▼ ▼ ▼ ▼ ▼ F3 ($r < \theta$) EXE	
Enter the calculation	3 SHIFT X,θ,T 1 • 6 ÷ 2 SHIFT X,θ,T 0 • 9 EXE	

You should write...

From GDC: $\frac{3e^{1.6i}}{2e^{0.9i}} = 1.5e^{0.7i}$

You can convert this answer into Cartesian form by pressing **OPTN** **F3** **F6** **F4** **EXE**

9 Differentiation

Finding the gradient of a tangent at a point

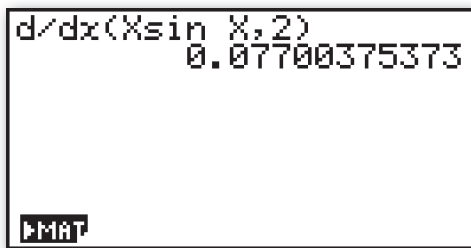
You will need...

- The equation of a curve
- The x -coordinate of the point of interest

In our example...

- $y = x \sin x$
- $x = 2$

How you do it...

Notes	You should press	You will see
(Make sure your calculator is in radians first; see Calculator skills 1 if required) Go to the Calculus (CALC) option in the RUN menu	MENU 1 (RUN) OPTN F4 (CALC)	
Use the syntax: $d/dx(\text{function}, x\text{-value})$	F2 (d/dx) X,θ,T sin X,θ,T , 2) EXE	

A similar method using **F3** (d^2/dx^2) in the calculus option will find the second derivative.

What to write down...

Gradient of $y = x \sin x$ when $x = 2$ is 0.0770 (3 SF) (from GDC)

* These instructions were written based on the CASIO model fx-9860G SD and might not be true for other models. If in doubt refer to your calculator's manual.

Sketching the derivative function

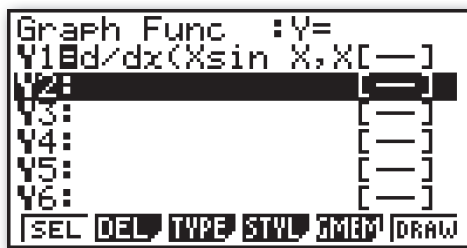
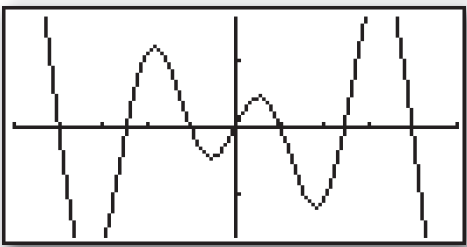
You will need...

- A function

In our example...

- $y = x \sin x$

How you do it...

Notes	You should press	You will see
Access the Graphing menu (GRAPH)	MENU 5 (GRAPH)	
Follow the process above with the x value being the graphing variable X	OPTN F2 (CALC) F1 (d/dx) X,θ,T sin X,θ,T , X,θ,T) EXE	
Sketch the graph	F6	

10 Integration

Finding a definite integral

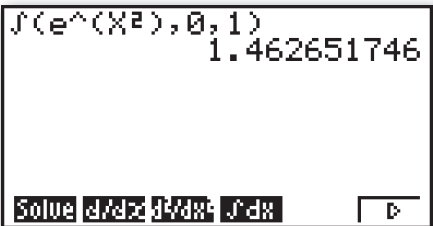
You will need...

- A function to integrate
- The limits of the integral

In our example...

- e^{x^2}
- $x = 0$ to $x = 1$

How you do it...

Notes	You should press	You will see
Go to the Calculus (CALC) option	MENU 1 (RUN) OPTN F4 (CALC)	
Use the syntax: $\int \frac{d}{dx}(\text{function}, x\text{-value})$	F4 (Integral) SHIFT In (X,0,T x^2) , 0 , 1) EXE	

You can also find the area under a graph when plotting it using the integral operation

(**F5**) (G-Solv) (**F6**) (>) (**F3**). This has the advantage that the associated area is shaded on the graph.

What to write down...

$$\int_0^1 e^{x^2} dx = 1.46 \text{ (3SF from GDC).}$$

* These instructions were written based on the CASIO model fx-9860G SD and might not be true for other models. If in doubt refer to your calculator's manual.

11 Working with lists

Entering numbers into lists

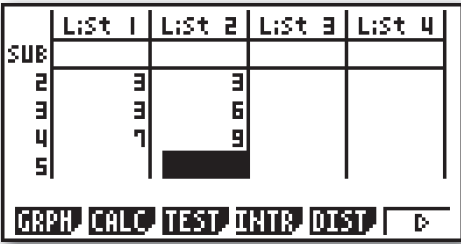
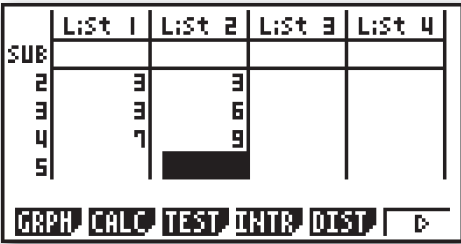
You will need...

- A list to enter
- Another list to enter

In our example...

- 1, 3, 3, 7
- 1, 3, 6, 9

How you do it...

Notes	You should press	You will see
Go to the Statistics Menu	MENU 2 (STAT)	
Enter the list	1 EXE 3 EXE 3 EXE 7 EXE	
Move to the next column	▶ 1 EXE 3 EXE 6 EXE 9 EXE	

* These instructions were written based on the CASIO model fx-9860G SD and might not be true for other models. If in doubt refer to your calculator's manual.

Doing a calculation on all items in a list

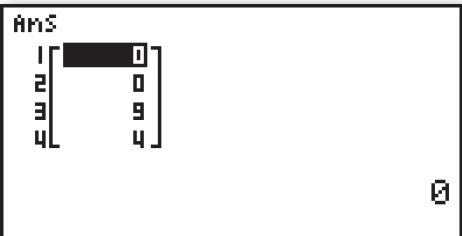
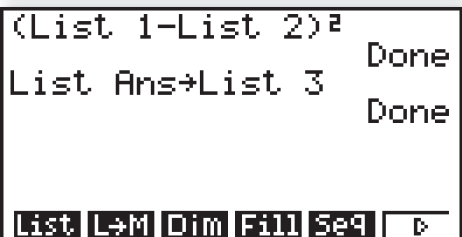
You will need...

- Data stored in a list
- An operation
- (Optionally) a list to store the answer

In our example...

- the lists above
- square all the differences
- list 3

How you do it...

Notes	You should press	You will see
In the RUN Menu access the List Option	MENU 1 (RUN) OPTN F1 (LIST)	
Perform the calculation	(F1 (List) 1 = F1 (List) 2) x² EXE	
The answer is stored in a variable <i>List Ans</i>	EXE F1 (List) SHIFT (←) (Ans) → F1 (List) 3 EXE	

12 Descriptive statistics

Finding statistics from a list

You will need...

- A list of data values
- (Optional) a list of data frequencies

In our example...

- in list L1: 1, 3, 12, 20
- in list L2: 21, 28, 14, 8

How you do it...

Notes	You should press	You will see
Go to the Statistics Menu and enter the lists (see Calculator skills 11)		
Access the Calculation Menu	F2 (CALC)	
Check the SETUP. If you have a list of frequencies you must enter that in 1 Var Freq. Otherwise, ensure that it is set to 1	F6 (SET) ▼ F2 (List) 2 EXE	
Perform 1VAR operation	EXIT F1 (1VAR)	
Scroll down to see further information	▼ ▼ ▼ ▼ ▼ ▼ ▼ ▼ ▼ ▼	

* These instructions were written based on the CASIO model fx-9860G SD and might not be true for other models. If in doubt refer to your calculator's manual.

Interpreting the information...

Symbol	Meaning	Notes
\bar{x}	Mean of the data	
Σx	Sum of the data	
Σx^2	Sum of the squares of the data	
$x\sigma_n$	Standard deviation of the data	
$x\sigma_{n-1}$	Estimate of the standard deviation of the population	May have a different symbol on different models
n	Number of data items	Useful for checking that data has been correctly entered
$\min X$	Smallest data value	
Q1	Lower quartile	
Med	Median	
Q3	Upper quartile	
$\max X$	Largest data value	
Mod	Mode	There may be more than one mode
Mod:n	How many modes exist	
Mod:F	The number of occurrences of each mode	

Each of these variables can be accessed for calculations in the RUN menu using **VAR** **F3** (Stat) **F1** (X).

13 Discrete probability distributions

Finding the probability of a single outcome

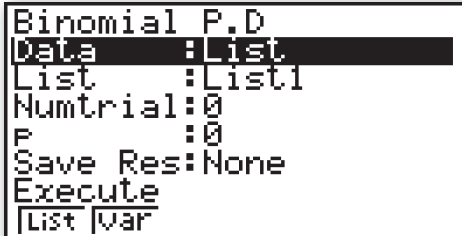
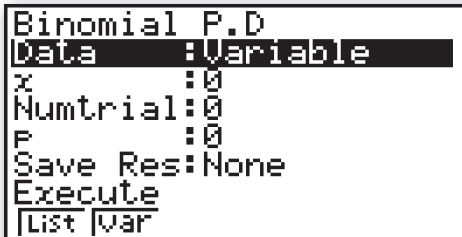
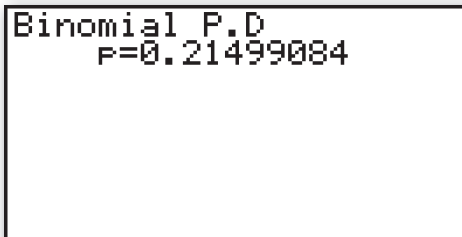
You will need...

- The distribution, including relevant parameters
- The outcome whose probability you want to find

In our example...

- $X \sim B(10, 0.4)$
- $P(X = 3)$

How you do it...

Notes	You should press	You will see
Go to the Statistics Menu (STAT) then the Distributions submenu (DIST)	MENU 2 F5 (DIST)	
Select the Binomial distribution (BINM) then select the Binomial Probability Distribution (Bpd)	F5 (BINM) F1 (Bpd)	
You are looking for the probability of a single outcome so change the data to Variable	F2	
Enter the parameters: x is the outcome of interest Numtrial is the number of trials p is the probability of a single success	▼ 3 EXE 1 0 EXE 0 . 4 EXE EXE	

What to write down...

$$X \sim B(10, 0.4)$$

$$\text{From GDC } P(X = 3) = 0.215 \text{ (3SF).}$$

* These instructions were written based on the CASIO model fx-9860G SD and might not be true for other models. If in doubt refer to your calculator's manual.

Finding a cumulative probability of a binomial distribution

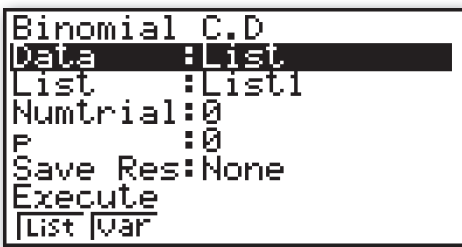
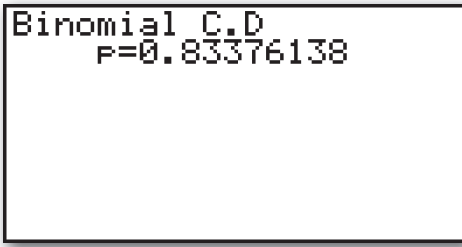
You will need...

- The relevant parameters
- The cumulative probability required

In our example...

- $X \sim B(10, 0.4)$
- $P(X \leq 5)$

How you do it...

Notes	You should press	You will see
Go to the Statistics Menu (STAT) then the Distributions submenu (DIST)	MENU 2 F5 (DIST)	
Select the Binomial distribution (BINM) then, since we want the cumulative probability, select the Binomial Cumulative Distribution (Bcd)	F5 (BINM) F2 (Bcd)	
You are looking for the probability of a single outcome so change the data to Variable	F2	
Enter the parameters: x is the outcome of interest Numtrial is the number of trials p is the probability of a single success	▼ 5 EXE 1 0 EXE 0 . 4 EXE EXE	

What to write down...

$$X \sim B(10, 0.4)$$

From GDC $P(X \leq 5) = 0.834$ (3SF).

Finding many probabilities in a Poisson distribution

The above methods can also be applied to the Poisson distribution by using the Poisson Option in the Distribution Submenu: **F6** (>) **F1** (POISN).

When finding the mode of a discrete distribution it can be useful to find the probabilities of lots of outcomes to see which one is most likely.

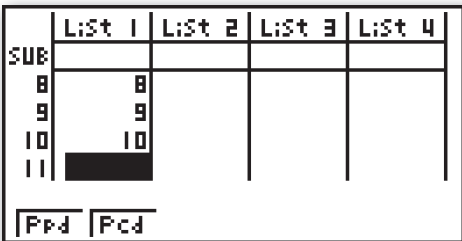
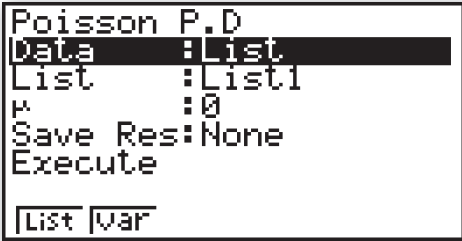

You will need...

- The distribution, including relevant parameters
- The range of outcomes whose probabilities you want to find stored as a list (see Calculator skills 11)

In our example...

- $X \sim \text{Po}(6)$
- 1,2,3 ... 10 in list 1

How you do it...

Notes	You should press	You will see
Go to the Statistics (STAT) then the Distributions submenu (DIST)	MENU 2 F5 (DIST)	
Select the Poisson distribution (POISN) then select the Poisson Probability Distribution (Ppd)	F6 (>) F1 (POISN). F1 (Ppd)	
You are looking for the probability of many outcomes so change the data to List	F1	
In our example the data is stored in List 1 so there is no need to change the list. Enter the parameters: μ is the average rate of successes. Then perform the calculation.	▼ ▼ 6 EXE EXE	

You can scroll up and down through the list of outcomes, but be aware that the numbers on the left correspond to the position in the list rather than the values that X takes.

14 Normal distribution

Finding a probability

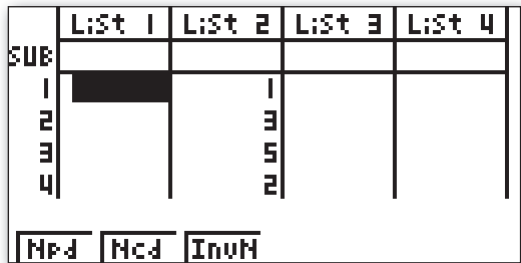
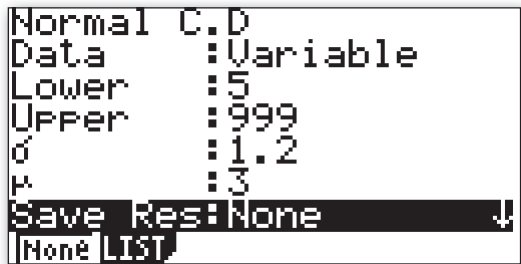
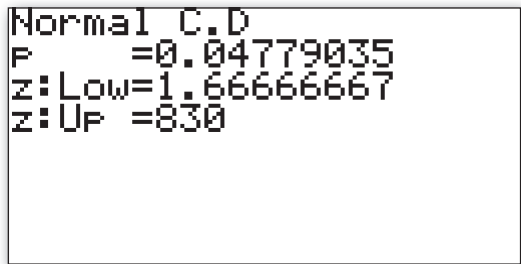
You will need...

- The values of μ and σ
- The probability you wish to find

In our example...

- $\mu = 3, \sigma = 1.2$
- $P(X \geq 5)$

How you do it...

Notes	You should press	You will see
To get to the correct menu (Normal distribution calculator)	MENU 2 (STAT) F5 (Dist) F1 (NORM)	
Select cumulative normal distribution and enter the parameters (in this case, enter a large number for the upper bound)	F2 (Ncd) F2 (Var) ∇ 5 EXE 9 9 9 EXE 1 . 2 EXE 3 EXE	
Calculate the probability	∇ F1 (CALC)	

Interpreting the results...

Symbol	Meaning
p	The required probability
z:Low	The z-score of the lower boundary
z:Up	The z-score of the upper boundary

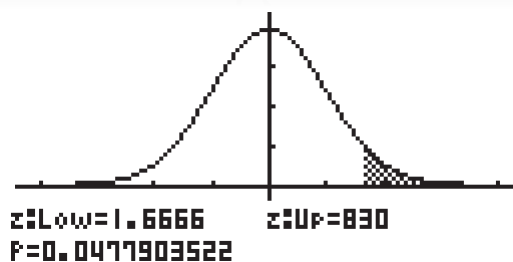
* These instructions were written based on the CASIO model fx-9860G SD and might not be true for other models. If in doubt refer to your calculator's manual.

What to write down...

$$X \sim N(3, 1.2^2)$$

From GDC $P(X \leq 5) = 0.0478$ (3SF).

If you select **F6** (DRAW) at the last step, you also get a shaded normal distribution diagram:



Finding the boundary

You will need...

- The parameters of the normal distribution
- Cumulative probability in the form $P(X \leq k)$

In our example

- $X \sim N(12, 7^2)$
- $P(X \leq k) = 0.42$

How you do it...

Notes	You should press	You will see
Go to the normal distribution calculator and select Inverse Normal	MENU 2 (STAT) F5 (DIST) F1 (NORM) F3 (InvN)	
Enter parameters: in this case we choose the left tail because the given probability is <i>below</i> k	F2 (Var) ∇ F1 (LEFT) ∇ 0 . 4 2 EXE 7 EXE 1 2 EXE	Inverse Normal Tail : Left \uparrow Area : 0.42 σ : 7 μ : 12 Save Res: None Execute CALC
Calculate	∇ F1 (CALC)	Inverse Normal xInv=10.5867456

What to write down...

$$X \sim N(12, 7^2)$$

$$P(X \leq k) = 0.42 \Rightarrow k = 10.6 \text{ (3 SF from GDC).}$$

15 Systems of simultaneous equations

You will need...

- A system of equations

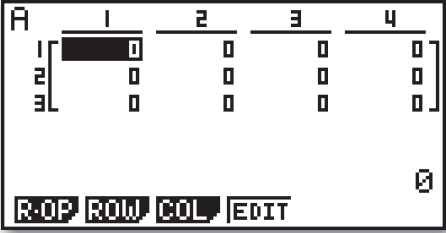
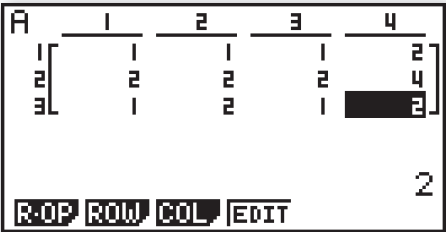
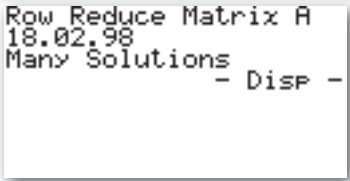
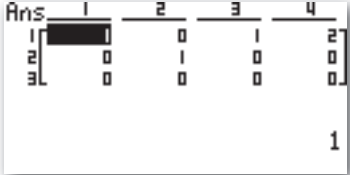
In our example...

- $x + y + z = 2$
 $2x + 2y + 2z = 4$
 $x + 2y + z = 2$

To put this into the calculator we need to rewrite it as a table of all of the numbers involved, called an augmented matrix:

$$\begin{pmatrix} 1 & 1 & 1 & 2 \\ 2 & 2 & 2 & 4 \\ 1 & 2 & 1 & 2 \end{pmatrix}$$

How you do it...

Notes	You should press	You will see
Set the dimensions of the matrix A to 3×4	MENU 1 (RUN) F1 (MAT) EXE 3 EXE 4 EXE EXE	
Input the augmented matrix	1 EXE 1 EXE 1 EXE 2 EXE 2 EXE 2 EXE 2 EXE 4 EXE 1 EXE 2 EXE 1 EXE 2 EXE	
Run the program 'ROWREDA'	MENU log (PRGM) ▼ ▼ ... ▼ (ROWREDA)	
See the triangular form of the equations	▼	

* These instructions were written based on the CASIO model fx-9860G SD and might not be true for other models. If in doubt refer to your calculator's manual.

What to write down...

The system of equations can be written as:

$$x + y + z = 2$$

$$y = 0$$

$$0 = 0$$

This is a consistent set of equations with an infinite number of solutions of the form:

$$y = 0, z = t, x = 2 - t.$$