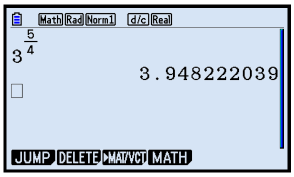
CHAPTER 1 - CALCULATING RATIONAL EXPONENTS

Casio fx-CG50

Exponents are calculated using $\wedge$.

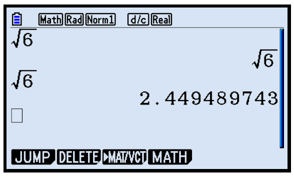
To find $3^{\frac{5}{4}}$, enter 3 $\wedge$ 5 $\frac{\blacksquare}{\square}$ 4 EXE.



Square roots are calculated by pressing SHIFT x^2 ($\sqrt{}$).

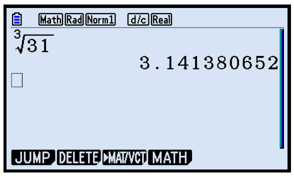
To find $\sqrt{6}$, press SHIFT x^2 ($\sqrt{}$) 6 EXE.

Note: Pressing S ↔ D switches between exact and decimal expressions (where possible).



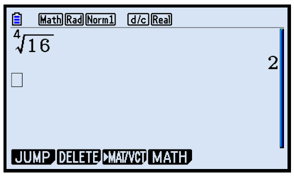
Cube roots are calculated by pressing SHIFT (($\sqrt[3]{}$).

To find $\sqrt[3]{31}$, press SHIFT (($\sqrt[3]{}$) 31 EXE.



Higher roots are calculated by pressing SHIFT $\wedge$ ($\sqrt[x]{}$).

To find $\sqrt[4]{16}$, enter 4 SHIFT $\wedge$ ($\sqrt[x]{}$) 16 EXE.



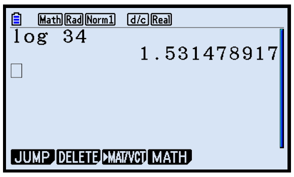
CHAPTER 2 - LOGARITHMS IN BASE 10

Casio fx-CG50

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

To evaluate $\log 34$, press **log** 34 **EXE**.

So, $\log 34 \approx 1.53$.



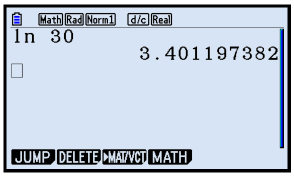
CHAPTER 2 - NATURAL LOGARITHMS

Casio fx-CG50

We can perform operations involving natural logarithms using the **ln** button.

To evaluate $\ln 30$, press **ln** 30 **EXE**.

So, $\ln 30 \approx 3.40$.



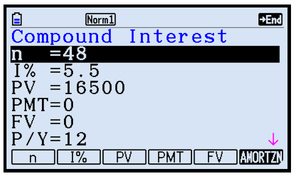
CHAPTER 4 - CALCULATING MONTHLY REPAYMENTS

Casio fx-CG50

Erica takes out a personal loan of $\$16\,500$ to buy a car. She negotiates a term of 4 years at 5.5% p.a. interest.

To calculate the monthly repayments, select **Financial** from the Main Menu.

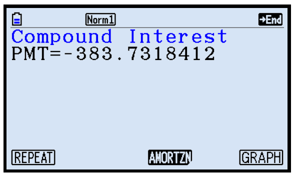
Press F2 (**COMPND**), and set up the screen as shown alongside.



We set:

- **n** $= 48$ since the term lasts for $4 \times 12 = 48$ months
- **I%** $= 5.5$ since the interest rate is 5.5% p.a.
- **PV** $= 16\,500$ since $\$16\,500$ is loaned
- **P/Y** $= 12$ since 12 monthly payments are made per year.

Press F4 (**PMT**) to calculate the monthly repayments.



So, the repayments are $\$383.74$ per month.

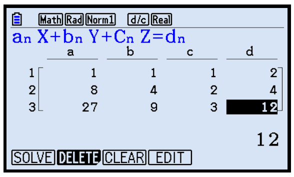
Note: The monthly repayment is always rounded up.

CHAPTER 5 - SOLVING SYSTEMS OF EQUATIONS

Casio fx-CG50

Consider the system of equations $\begin{cases} a+b+c=2 \\ 8a+4b+2c=4 \\ 27a+9b+3c=12. \end{cases}$

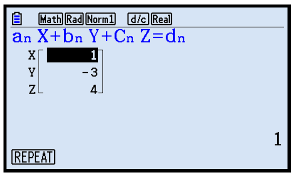
To solve these equations simultaneously, select **Equation** from the Main Menu.



Press F1 (**SIMUL**), then F2 (**3**) to enter 3 unknowns.

Set up the screen as shown alongside.

Note: The numbers correspond to the coefficients and the right hand side of each equation.



Press F1 (**SOLVE**) to view the results.

So, $a=1$, $b=-3$, and $c=4$.

CHAPTER 6 - VARIATION MODELS

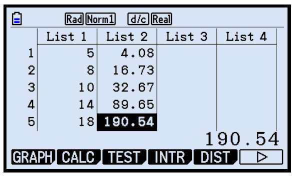
Casio fx-CG50

To perform a power regression on the data shown alongside, it must first be entered into the calculator.

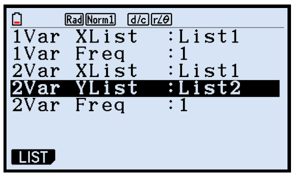
r	5	8	10	14	18
M	4.08	16.73	32.67	89.65	190.54

To add the data, press **MENU** and select **Statistics**.

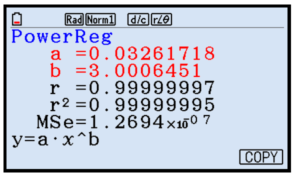
Enter the data above in **List 1** and **List 2**, as shown in the screenshot.



Press F2 (**CALC**), F6 (**SET**), and set up the screen as shown.



To perform the regression, press **EXIT**, F3 (**REG**), F6 (▷), and then F3 (**Power**).



So, $M \approx 0.0326r^3$.

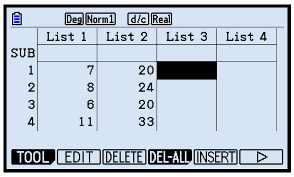
CHAPTER 7 - DRAWING SCATTER DIAGRAMS

Casio fx-CG50

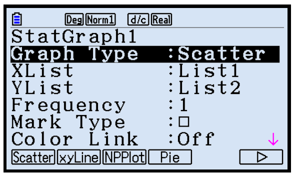
Draw a scatter diagram of the following data set:

x	7	8	6	11	6	4	5
y	20	24	20	33	18	10	13

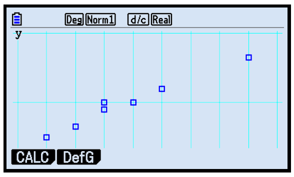
Enter the x-values into **List 1** and the y-values into **List 2**.



Press F1 (**GRAPH**), F6 (**SET**), and set up **StatGraph1** as shown.



Press **EXIT**, then F1 (**GRAPH1**) to draw the scatter diagram.



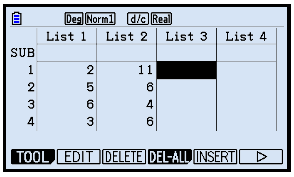
CHAPTER 7 - CALCULATING r

Casio fx-CG50

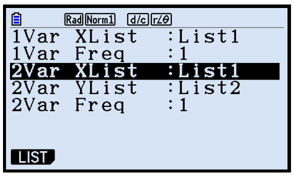
Find the correlation coefficient r for the data alongside.

x	2	5	6	3	9
y	11	6	4	6	3

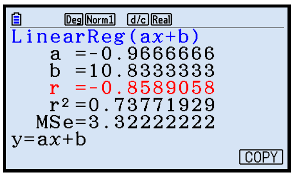
Enter the x-values into **List 1**, and the y-values into **List 2**.



Press F2 (**CALC**), F6 (**SET**), and set up the screen as shown alongside.



Press **EXIT**, F3 (**REG**), F1 (**X**), then F1 (**ax+b**).



So, $r \approx -0.859$.

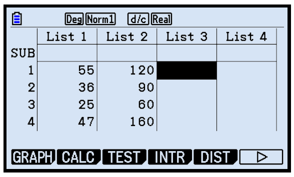
CHAPTER 7 - REGRESSION LINE

Casio fx-CG50

Find the regression line for the data alongside.

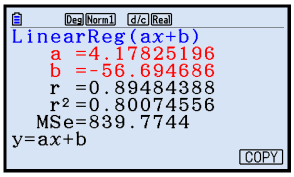
x	55	36	25	47	60	64	42	50
y	120	90	60	160	190	250	110	150

Enter the x-values into **List 1**, and the y-values into **List 2**.



Press **F2** (**CALC**), **F6** (**SET**), and set up the screen as shown alongside.

Press **EXIT**, **F3** (**REG**), **F1** (**X**), then **F1** (**ax+b**).



So, the regression line is $y \approx 4.18x - 56.7$.

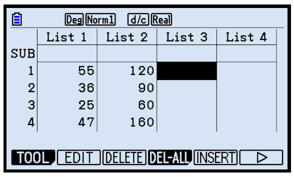
CHAPTER 7 - REGRESSION LINE ON A SCATTER DIAGRAM

Casio fx-CG50

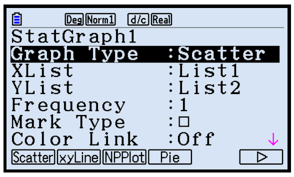
Plot the regression line on the scatter diagram of the data below:

x	55	36	25	47	60	64	42	50
y	120	90	60	160	190	250	110	150

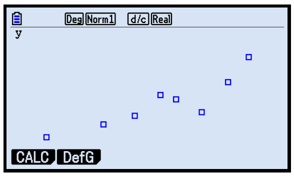
First enter the x-values into **List 1**, and the y-values into **List 2**.



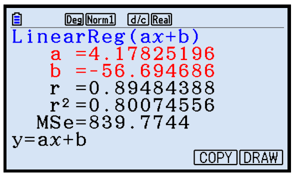
Press F1 (**GRAPH**), F6 (**SET**), and set up **StatGraph1** as shown.



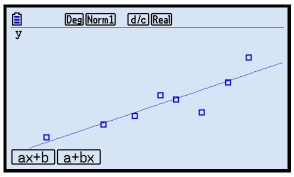
Press **EXIT**, then F1 (**GRAPH1**) to draw a scatter diagram of the data.



Press F1 (**CALC**), F2 (**X**), F1 (**ax+b**) to perform a linear regression on the data. So, the regression line is $y \approx 4.18x - 56.7$.



Press F6 (**DRAW**) to plot the regression line on the scatter diagram.



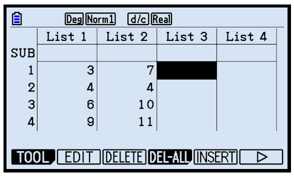
CHAPTER 7 - CONSTRUCTING RESIDUAL PLOTS

Casio fx-CG50

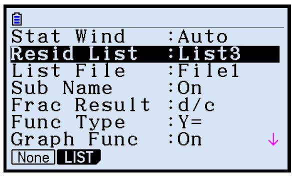
Construct a residual plot for the data set alongside.

x	3	4	6	9	11
y	7	4	10	11	20

First enter the x-values into **List 1**, and the y-values into **List 2**.

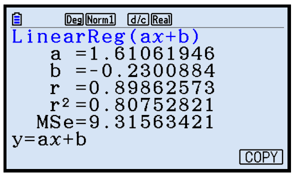


Press **SHIFT** **MENU** (**SET UP**) and enter **List 3** for **Resid List** as shown, then press **EXIT**.

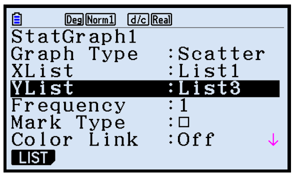


Perform linear regression for the data set.

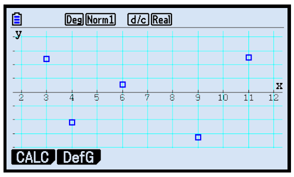
The residuals are stored in **List 3**.



Press **SHIFT** **EXIT** (**QUIT**), **F1** (**GRAPH**), **F6** (**SET**), set up the screen as shown, then press **EXIT** when you are done.



Press **F1** (**GRAPH1**) to graph the residual plot.



CHAPTER 8 - LOGARITHMIC MODELLING

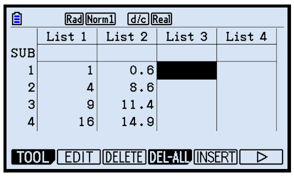
Casio fx-CG50

Find a logarithmic model relating the data alongside.

x	1	4	9	16	25
y	0.6	8.6	11.4	14.9	18

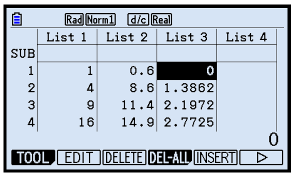
First select **Statistics** from the Main Menu.

Enter the x-values into **List 1**, and the y-values into **List 2**.



Highlight the header of **List 3** and press **ln** **SHIFT** **1** (**List**) 1 **EXE**.

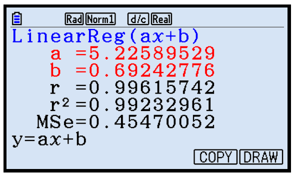
This populates **List 3** with the values of $\ln x$.



Press **SHIFT** **EXIT** (**QUIT**), **F2** (**CALC**), then **F6** (**SET**).

Set up the screen as shown alongside.

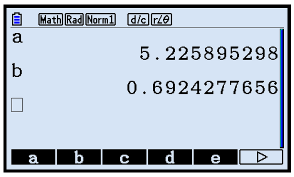
Press **EXIT**, **F3** (**REG**), **F1** (**X**), then **F1** (**ax+b**) to find the linear model connecting y and $\ln x$.



So, $y \approx 5.23 \ln x + 0.692$.

Note: The regression coefficients are stored in the variables **a** and **b**.

To access these variables, select **Run-Matrix** from the Main Menu, press **VARS**, **F3** (**STAT**), **F3** (**GRAPH**), then press **F1** (**a**) or **F2** (**b**).



CHAPTER 8 - EXPONENTIAL MODELLING

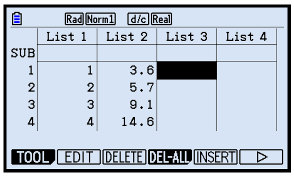
Casio fx-CG50

The mass of bacteria in a culture is measured each day for five days.

t (days)	1	2	3	4	5
M (grams)	3.6	5.7	9.1	14.6	23.3

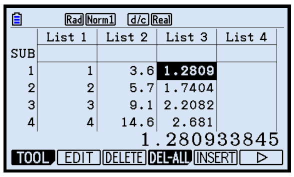
To find an exponential model relating M and t, select **Statistics** from the Main Menu.

Enter the t-values into **List 1**, and the M-values into **List 2**.



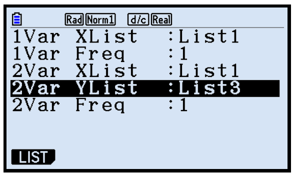
Highlight the header of **List 3** and press **ln** **SHIFT** **1** (**List**) 2 **EXE**.

This populates **List 3** with the values of $\ln M$.

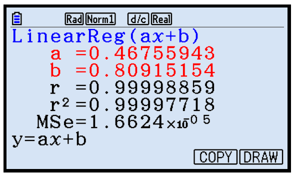


Press **SHIFT** **EXIT** (**QUIT**), **F2** (**CALC**), then **F6** (**SET**).

Set up the screen as shown alongside.



Press **EXIT**, **F3** (**REG**), **F1** (**X**), then **F1** (**ax+b**), to find the linear model connecting $\ln M$ and t.



So, $\ln M \approx 0.468t + 0.809$

$\therefore \quad M \approx e^{0.468t+0.809}$

$\therefore \quad M \approx e^{0.468t} \times e^{0.809}$

$\therefore \quad M \approx e^{0.809} \times (e^{0.468})^t$

$\therefore \quad M \approx 2.25 \times (1.60)^t$

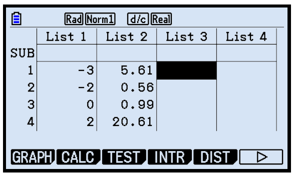
CHAPTER 8 - POLYNOMIAL MODELLING

Casio fx-CG50

Fit a quadratic, cubic, and quartic model to the data below:

x	-3	-2	0	2	-4	3	-1	5	1	-5	4
y	5.61	0.56	0.99	20.61	18.15	29.8	2.72	70.57	6.55	30.38	49.38

First select **Statistics** from the Main Menu.
Enter the x-values into **List 1**, and the y-values into **List 2**.

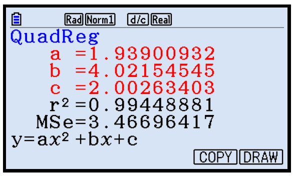


Press F2 (**CALC**), F6 (**SET**), and set up the screen as shown alongside.

Press **EXIT** when you are done.

Quadratic modelling

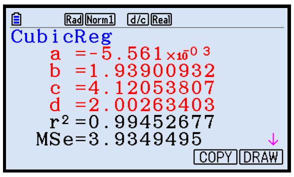
To find a quadratic model, press F3 (**REG**), then F3 (**X²**).



So, $y \approx 1.94x^2 + 4.02x + 2.00$.

Cubic modelling

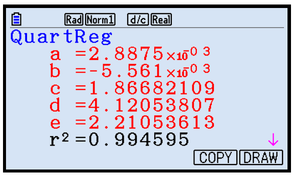
To find a cubic model, press F3 (**REG**), then F4 (**X³**).



So, $y \approx -0.00556x^3 + 1.94x^2 + 4.12x + 2.00$.

Quartic modelling

To find a quadratic model, press F3 (**REG**), then F5 (**X⁴**).



So, $y \approx 0.00289x^4 - 0.00556x^3 + 1.87x^2 + 4.12x + 2.21$.

CHAPTER 8 - QUADRATIC MODELLING

Casio fx-CG50

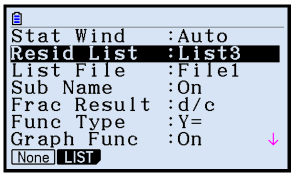
Fit a quadratic model to the data alongside, and find SS_{res} for the model.

x	2	4	6	8	10	12
y	10	8	6	9	12	14

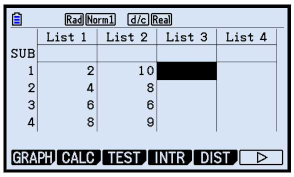
First select **Statistics** from the Main Menu.

Press **SHIFT** **MENU** (**SET UP**), and set **Resid List** to **List 3**.

This will store the residuals of the quadratic regression in **List 3**, which we need to calculate SS_{res} for the model.

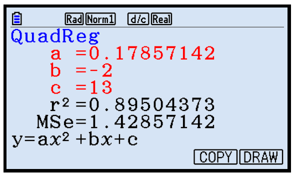


Enter the x-values into **List 1**, and the y-values into **List 2**.



Press **F2** (**CALC**), **F6** (**SET**), and set up the screen as shown alongside.

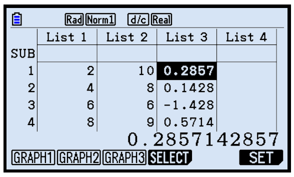
Press **EXIT**, **F3** (**REG**), then **F3** (**X^2**) to find the quadratic model.



So, $y \approx 0.179x^2 - 2x + 13$.

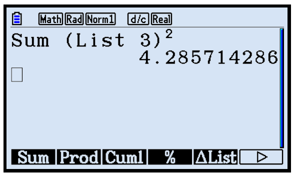
Press **SHIFT** **EXIT** (**QUIT**) to return to the list view.

Note: **List 3** has been populated with the residuals of the quadratic regression.



To find SS_{res}, we find the sum of the squares of the values in **List 3**.

Press **MENU**, select **Run-Matrix**, press **OPTN** **F1** (**LIST**), **F6** (▷), **F6** (▷), **F1** (**Sum**), then **(** **SHIFT** **1** (**List**) 3 **)** **x^2** **EXE**.



So, $SS_{\text{res}} \approx 4.29$.

CHAPTER 11 - OPERATIONS WITH COMPLEX NUMBERS

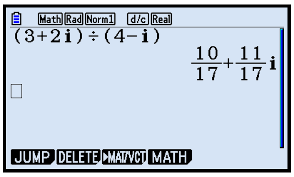
Casio fx-CG50

The imaginary number i is entered by pressing **SHIFT** **0** (i).

For example, suppose $z = 3 + 2i$, and $w = 4 - i$.

To calculate $\frac{z}{w}$, enter $(3 + 2i) \div (4 - i)$, then press **EXE**.

Note: Press **S ↔ D** to display the answer in fractional form.



So, $\frac{z}{w} = \frac{10}{17} + \frac{11}{17}i$.

CHAPTER 11 - CONVERTING BETWEEN POLAR AND CARTESIAN FORM

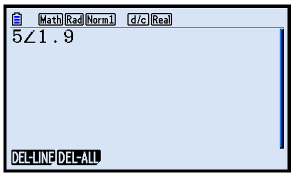
Casio fx-CG50

Select **Run-Matrix** from the Main Menu. Press **SHIFT** **MENU** (**SET UP**), and ensure that **Angle** is set to **Rad**. Press **EXIT** to return.

Polar to Cartesian form

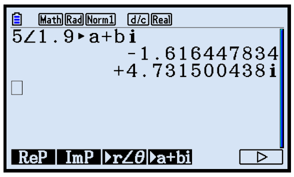
Enter complex numbers in polar form using the angle function $\angle$.

For example, to input $5\,\text{cis}(1.9)$, enter 5 **SHIFT** **X, θ, T** ($\angle$) 1.9 .



To convert complex numbers in polar form to Cartesian form, use the **►a+bi** function.

For example, to convert $5\,\text{cis}(1.9)$ to Cartesian form, enter $5\,\text{cis}(1.9)$, then press **OPTN** **F3** (**COMPLEX**), **F6** (▷), **F4** (**►a+bi**), then **EXE**.



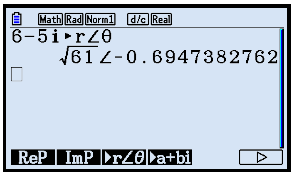
So, $5\,\text{cis}(1.9) \approx -1.62 + 4.73i$.

Cartesian to polar form

To convert complex numberts in Cartesian form to polar form, use the **►r∠θ** function.

For example, to convert $6 - 5i$ to polar form, first enter $6 - 5i$, then press **OPTN** **F3** (**COMPLEX**), **F6** (▷), **F3** (**►r∠θ**), then **EXE**.

Note: i is entered by pressing **SHIFT** **0** (i).



So, $6 - 5i \approx \sqrt{61}\,\text{cis}(-0.695)$.

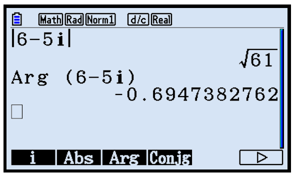
Alternatively, the modulus and argument may be calculated separately using the **Abs** and **Arg** functions.

To find the modulus, press **OPTN** **F3** (**COMPLEX**), **F2** (**Abs**).

Enter $6 - 5i$, then press **EXE**.

To find the argument, press **OPTN** **F3** (**COMPLEX**), **F3** (**Arg**).

Enter $6 - 5i$, then press **EXE**.



So, $|6 - 5i| = \sqrt{61}$, and $\arg(6 - 5i) \approx -0.695$

$\therefore\ 6 - 5i \approx 7.81\,\text{cis}(-0.695)$.

Note: The calculator has a **Complex Mode** setting, accessed by pressing **SHIFT** **MENU** (**SET UP**).

When set to **a+bi**, complex numbers in polar form are converted to Cartesian form after pressing **EXE**.

When set to **r∠θ**, complex numbers in Cartesian form are converted to polar form after pressing **EXE**.

CHAPTER 11 - CONVERTING BETWEEN EXPONENTIAL AND CARTESIAN FORM

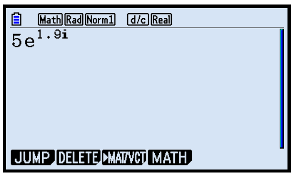
Casio fx-CG50

Select **Run-Matrix** from the Main Menu. Press SHIFT MENU (**SET UP**), and ensure that **Angle** is set to **Rad**. Press EXIT to return.

Exponential to Cartesian form

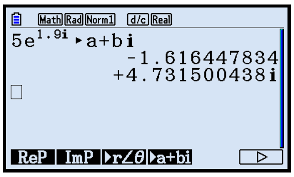
Enter complex numbers in exponential form using the exponential function e^x.

For example, to input $5e^{1.9i}$, enter 5 SHIFT ln (e^x) 1.9 SHIFT 0 (i).



To convert complex numbers in exponential form to Cartesian form, use the **▶a+bi** function.

For example, to convert $5e^{1.9i}$ to Cartesian form, enter $5e^{1.9i}$, then press OPTN F3 (**COMPLEX**), F6 (▷), F4 (**▶a+bi**), then EXE.



So, $5e^{1.9i} \approx -1.62 + 4.73i$.

Cartesian to exponential form

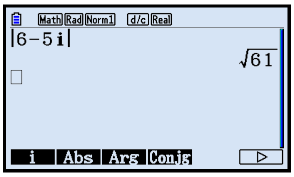
To convert complex numberts in Cartesian form to exponential form, use the **Abs** and **Arg** functions.

For example, to convert $6 - 5i$ to exponential form, we find the modulus and argument separately.

To find the modulus, press OPTN F3 (**COMPLEX**), F2 (**Abs**).

Enter $6 - 5i$, then press EXE.

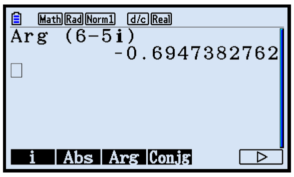
So, $|6 - 5i| = \sqrt{61}$.



To find the argument, press OPTN F3 (**COMPLEX**), F3 (**Arg**).

Enter $6 - 5i$, then press EXE.

So, $\arg(6 - 5i) \approx -0.695$.



So, $6 - 5i \approx \sqrt{61}e^{-0.695i}$.

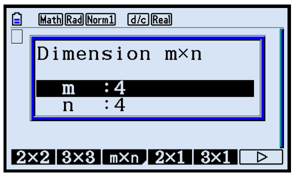
CHAPTER 12 - INVERSE OF A LARGER SQUARE MATRIX

Casio fx-CG50

To find the inverse of a square matrix, use the inverse function x^{-1}.

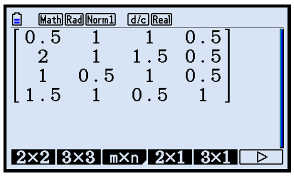
For example, consider the matrix $\mathbf{A}=\begin{pmatrix}0.5 & 1 & 1 & 0.5\\ 2 & 1 & 1.5 & 0.5\\ 1 & 0.5 & 1 & 0.5\\ 1.5 & 1 & 0.5 & 1\end{pmatrix}$.

To find $\mathbf{A}^{-1}$, first select **Run-Matrix** from the Main Menu.

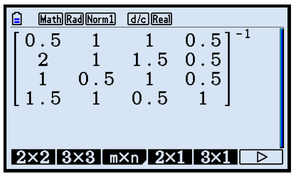


Press F4 (**MATH**), F1 (**MAT/VCT**), then F3 (**m**×**n**).

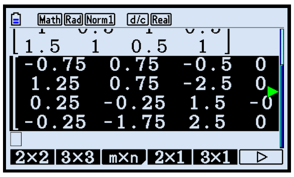
Since **A** is a 4×4 matrix, set **m** and **n** to **4**.

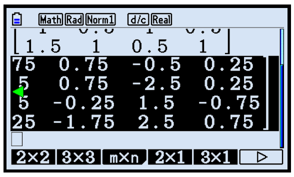


Press **EXE** and use the ▶ button to populate the matrix from left to right, and top to bottom row as shown alongside.



Press ▶ so that the cursor lies to the right of the matrix, and press **SHIFT** **)** ($\boldsymbol{x^{-1}}$).

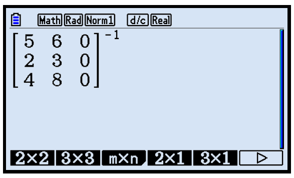


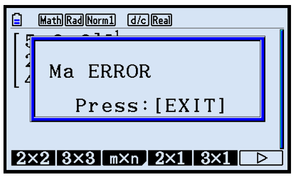


Press **EXE** to find the inverse of **A**.

Note: Use the arrow keys to highlight the output and view the whole matrix.

So, $\mathbf{A}^{-1}=\begin{pmatrix}-0.75 & 0.75 & -0.5 & 0.25\\ 1.25 & 0.75 & -2.5 & 0.25\\ 0.25 & -0.25 & 1.5 & -0.75\\ -0.25 & -1.75 & 2.5 & 0.75\end{pmatrix}$.



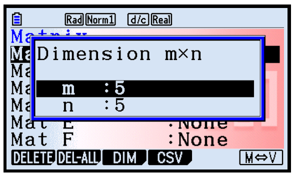


Note: If the matrix is *not* invertible, then the message **Ma ERROR** will appear.

Casio fx-CG50

To find the powers of the adjacency matrix $\mathbf{A} = \begin{pmatrix} 0 & 1 & 0 & 0 & 1 \\ 1 & 0 & 1 & 1 & 1 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 1 & 0 \end{pmatrix}$, first select **Run-Matrix** from the Main Menu.

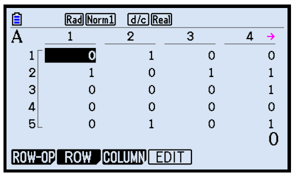
Since we will need to calculate $\mathbf{A}^2$, $\mathbf{A}^3$, and $\mathbf{A}^4$, store $\mathbf{A}$ in the variable **Mat A** to access it later.



To do this, press F3 (▶ **MAT/VCT**), select **Mat A**, then press **EXE**.

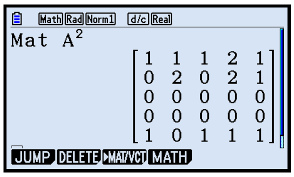
Since **A** is a 5×5 matrix, set **m** and **n** to **5**.

Note: If **Mat A** is *not* set to **None**, press F3 (**DIM**) to set the matrix dimensions.



Press **EXE** and populate the matrix as shown alongside.

Press **EXIT** twice to return to the **Run-Matrix** screen.

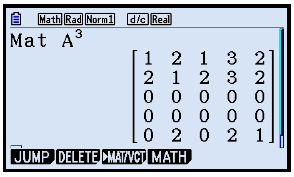


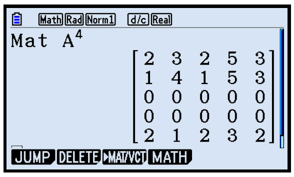
To find $\mathbf{A}^2$, press **SHIFT** 2 (**Mat**), **ALPHA** X, θ, T (**A**), then ∧ 2 **EXE**.

Note: You can press x^2 instead of ∧ 2.

So, $\mathbf{A}^2 = \begin{pmatrix} 1 & 1 & 1 & 2 & 1 \\ 0 & 2 & 0 & 2 & 1 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 1 & 1 \end{pmatrix}$.

We find $\mathbf{A}^3$ and $\mathbf{A}^4$ in a similar way.





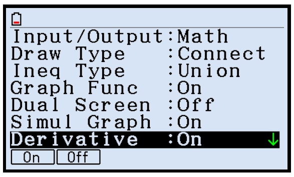
So, $\mathbf{A}^3 = \begin{pmatrix} 1 & 2 & 1 & 3 & 2 \\ 2 & 1 & 2 & 3 & 2 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 2 & 0 & 2 & 1 \end{pmatrix}$, and $\mathbf{A}^3 = \begin{pmatrix} 2 & 3 & 2 & 5 & 3 \\ 1 & 4 & 1 & 5 & 3 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 2 & 1 & 2 & 3 & 2 \end{pmatrix}$.

CHAPTER 17 - GRADIENT OF A TANGENT

Casio fx-CG50

To find the gradient of the tangent to $y = x^2$ when $x = 2$, we first select **Graph** from the Main Menu.

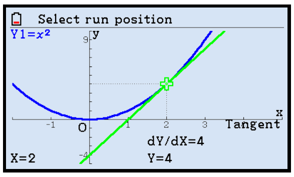
Press **SHIFT** **MENU** (**SET UP**), and make sure the **Derivative** setting is **On**.



Draw the graph of $y = x^2$, then press **SHIFT** **F4** (**SKETCH**) **F2** (**Tangent**).

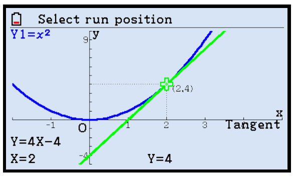
Press 2 **EXE**.

We can see that the tangent has a gradient of 4 at this point.



Press **EXE** again to find the equation of the tangent.

The tangent has equation $y = 4x - 4$.

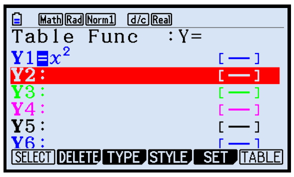


CHAPTER 17 - TABLE OF GRADIENTS

Casio fx-CG50

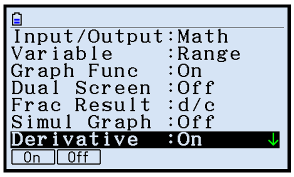
Construct a table of gradients of $y = x^2$ for $x = -2, -1, 0, 1,$ and 2.

First press **MENU**, select **Table**, then enter x^2 in **Y1** and press **EXE**.

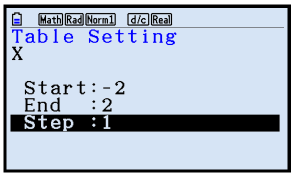


Press **SHIFT** **MENU** (**SET UP**), and ensure that **Derivative** is set to **On**.

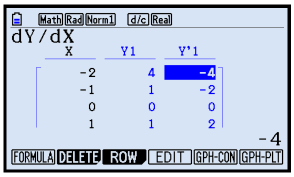
Press **EXIT** when you are done.



Press **F5** (**SET**) and set **Start** to -2, **End** to 2, and **Step** to 1.



Press **EXIT**, **F6** (**TABLE**), and the selected values of $\frac{dy}{dx}$ are displayed in **Y'1**.



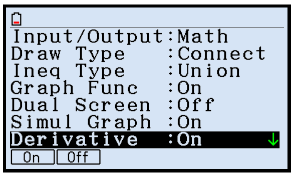
So, the table of gradients for $y = x^2$ is

x	-2	-1	0	1	2
$\frac{dy}{dx}$	-4	-2	0	2	4

CHAPTER 19 - EQUATION OF A TANGENT

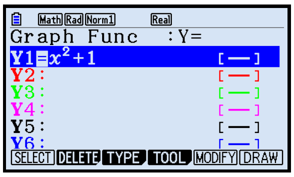
Casio fx-CG50

To find the equation of the tangent to $f(x) = x^2 + 1$ at the point where $x = 1$, start by pressing **MENU**, then select **Graph**.

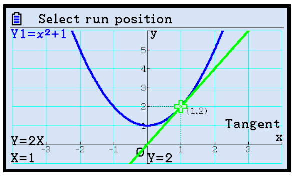


Press **SHIFT** **MENU** (**SET UP**), and make sure the **Derivative** setting is **On**.

Press **EXIT** when you are done.



Set up the screen as shown, then press **F6** (**DRAW**).



Press **F4** (**Sketch**), then **F2** (**Tangent**). Enter **1**, and then press **EXE** twice.

Your screen should now look like the screenshot alongside, displaying the equation **Y=2X** in the bottom-left.

So, the equation of the tangent to $f(x)$ at $x = 1$ is $y = 2x$.

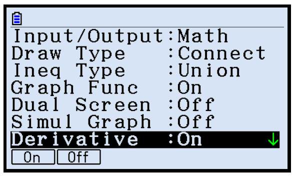
CHAPTER 19 - EQUATION OF A NORMAL

Casio fx-CG50

To find the equation of the normal to $y = \frac{8}{\sqrt{x}}$ at the point where $x = 4$, select **Graph** from the Main Menu.

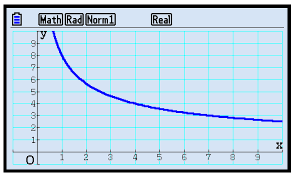
Press SHIFT MENU (**SET UP**) and ensure that **Derivative** is set to **On**.

Press EXIT when you are done.



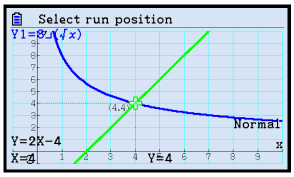
Enter $\frac{8}{\sqrt{x}}$ into **Y1**, and press EXE, then F6 (**DRAW**) to draw the graph.

Note: Press SHIFT F3 (**V-WIN**) to adjust the view window.



Press SHIFT F4 (**SKETCH**), F3 (**Norm**), then 4 EXE EXE.

The equation of the normal appears in the bottom left corner of the screen.

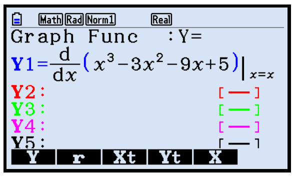


So, the equation of the normal is $y = 2x - 4$.

CHAPTER 19 - FINDING AND CLASSIFYING STATIONARY POINTS

Casio fx-CG50

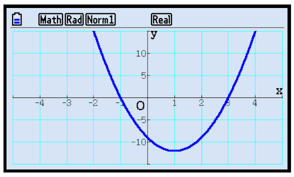
Construct a sign diagram for $f'(x)$, where $f(x) = x^3 - 3x^2 - 9x + 5$, by drawing the graph of $f'(x)$, and solving $f'(x) = 0$.



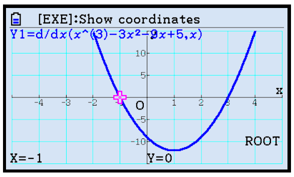
Select **Graph** from the Main Menu, and enter $\frac{d}{dx}(x^3 - 3x^2 - 9x + 5)$ in **Y1** as shown.

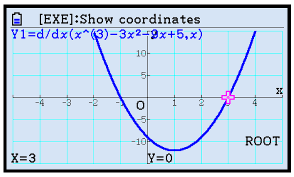
Note: To enter a derivative, press OPTN F2 (**CALC**), then F1 (**d/dx**).

Make sure to set **x=x** on the right hand side.



Press F6 (**DRAW**) to draw the graph, and adjust the view window as needed by pressing SHIFT F3 (**V-WIN**).





Press SHIFT F5 (**G-SOLVE**), then F1 (**ROOT**), and the first zero of $f'(x)$ will be displayed.

Press ▶ to view the remaining zero.

So, $f'(x) = 0$ when $x = -1$ or 3.

We also observe that $f'(x) \geqslant 0$ when $x \leqslant -1$ or $x \geqslant 3$, and $f'(x) \leqslant 0$ when $-1 \leqslant x \leqslant 3$.

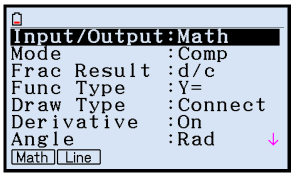
CHAPTER 21 - ESTIMATING AREA USING RECTANGLES

Casio fx-CG50

To calculate the lower and upper sums for the area between the graph of $y = x^2$ and the x-axis on the interval $0 \leqslant x \leqslant 1$ using 4 equal subdivisions, select **Run-Matrix** from the Main Menu.

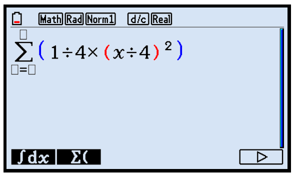
Press **SHIFT** **MENU** (**SET UP**) and make sure **Input/Output** is set to **Math**.

Then press **EXIT**.



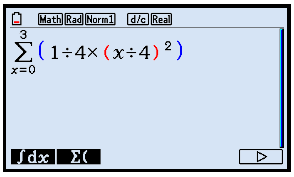
Press **F4** (**MATH**), **F6** (▷), **F2** ($\sum$() to insert a sum operator.

Enter the expression $(1 \div 4) \times (x \div 4)^2$.

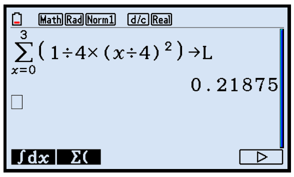


We will first calculate the lower sum.

Press ▶ **X, θ, T** ▶ 0 ▶ 3 to indicate that x ranges from 0 to 3.

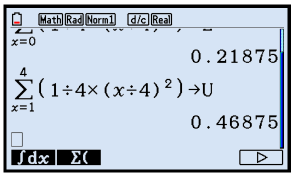


Press ▶ **→** **ALPHA** **→** (**L**) followed by **EXE** to calculate the lower sum and store it in the variable **L**.

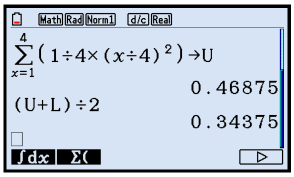


We can repeat this process to calculate the upper sum.

The only difference is that x ranges from 1 to 4 instead of 0 to 3 and we store the result in a different variable **U**.



Finally, calculate the average of the upper and lower sums $(\mathbf{U} + \mathbf{L}) \div 2$ to obtain an estimate of the area.



Note: You should be able to adapt these instructions to calculate lower and upper sums for different values of n (the number of subdivisions).

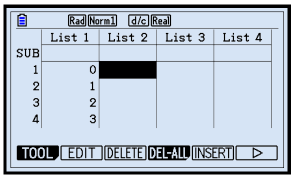
CHAPTER 21 - TRAPEZOIDAL RULE

Casio fx-CG50

Construct a table of values to use for the trapezoidal rule where $n = 6$, $a = 1$, $b = 2$, and $f(x) = \sqrt{6 - x^2}$.

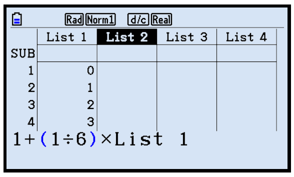
First, we find that $h = \dfrac{b-a}{n} = \dfrac{1}{6}$, and $x_i = a + ih = 1 + \frac{1}{6}i$.

To start, select **Statistics** from the Main Menu, and enter the values of i from 0 to $n = 6$ into **List 1**.

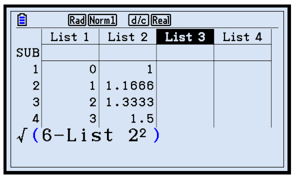


Enter the values for x_i into **List 2** by moving the cursor to the header of **List 2**, and entering $1 + (1 \div 6)) \times$ **List 1**.

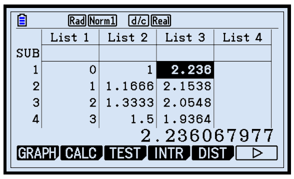
Note: To enter **List 1**, press SHIFT 1 (**List**) 1.



Enter the values for $f(x_i)$ into **List 3** by moving the cursor to the header of the list, then entering $\sqrt{\ }$ **(6-List 2^2)**.



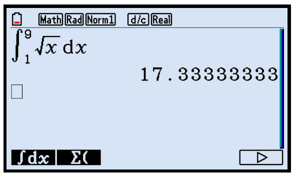
Press EXE, and **List 3** will be populated with the results.



CHAPTER 21 - DEFINITE INTEGRALS

Casio fx-CG50

To find $\int_1^9 \sqrt{x}\,dx$, select **Run-Matrix** from the Main Menu, and press F4 (**MATH**), F6 (▷), F1 ($\int$ dx).

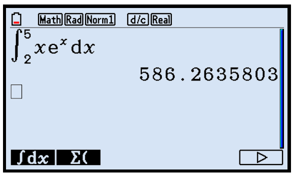


Set up the screen as shown and press **EXE**.

So, $\int_1^9 \sqrt{x}\,dx = 17\frac{1}{3}$.

CHAPTER 23 - EVALUATING DEFINITE INTEGRALS

Casio fx-CG50



To find $\int_2^5 xe^x \, dx$, select **Run-Matrix** from the Main Menu, and press F4 (**MATH**) F6 (▷) F1 ($\int$ $\boldsymbol{dx}$).

Set up the screen as shown and press EXE.

Note: e is accessed by pressing SHIFT ln ($\boldsymbol{e^x}$).

So, $\int_2^5 xe^x \, dx \approx 586.3$.

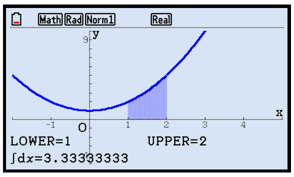
CHAPTER 23 - AREA UNDER CURVES

Casio fx-CG50

To find the area enclosed by $y = x^2 + 1$, the x-axis, $x = 1$, and $x = 2$, we first draw the graph of $y = x^2 + 1$.

Press F5 (G-SOLVE) F6 (▷) F3 ($\int dx$) F1 ($\int dx$) to select the integral tool.

Press 1 EXE 2 EXE to specify the lower and upper bounds of the integral.



So, the area of the region is $3\frac{1}{3}$ units^2.

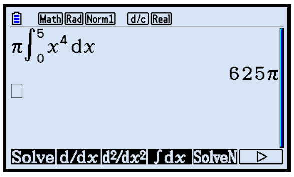
CHAPTER 23 - VOLUMES OF REVOLUTION

Casio fx-CG50

The volume of the solid formed when the graph of the function $y = x^2$ for $0 \leqslant x \leqslant 5$ is revolved through 2π about the x-axis, is given by $\pi \int_0^5 x^4\,dx$.

To evaluate this integral, first select **Run-Matrix** from the Main Menu.

Enter the expression as shown alongside, and press **EXE**.



Note: π is entered by pressing **SHIFT** **$\times 10^x$** (π).

To enter the integral sign, press **OPTN** **F4** (**CALC**), then **F4** ($\int$ dx).

So, volume of revolution $= 625\pi$ units^3.

CHAPTER 25 - EULER'S METHOD

Casio fx-CG50

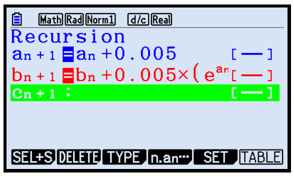
Consider the differential equation $\frac{dy}{dx} = e^x + 1$ with $y(0) = 1$.

To estimate $y(0.5)$ using Euler's method with step size 0.005, we have $x_0 = 0$, $y_0 = 1$, and

$$\begin{cases} x_i = x_{i-1} + 0.005 \\ y_i = y_{i-1} + 0.005(e^{x_{i-1}} + 1). \end{cases}$$

Select **Recursion** from the Main Menu, press F3 (**TYPE**), then F2 ($\mathbf{a_{n+1}}$).

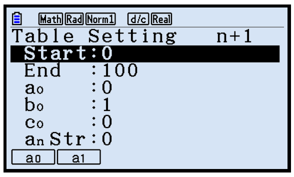
Enter $a_n + 0.005$ into $\mathbf{a_{n+1}}$, and $b_n + 0.005(e^{a_n} + 1)$ into $\mathbf{b_{n+1}}$.



Note: a_n is entered by pressing F4 ($\mathbf{n.a_n}\cdots$), then F2 ($\mathbf{a_n}$).

b_n is entered by pressing F4 ($\mathbf{n.a_n}\cdots$), then F3 ($\mathbf{b_n}$).

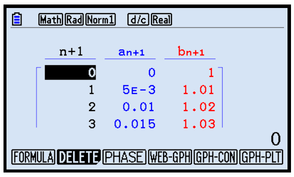
Press F5 (**SET**) and adjust the table settings.



Set **Start** $= 0$, and **End** $= 100$ since we are taking $\frac{0.5}{0.005} = 100$ steps.

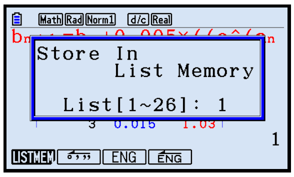
Set $\mathbf{a_0} = 0$ since $x_0 = 0$, and $\mathbf{b_0} = 1$ since $y_0 = 1$.

Press **EXIT**, then F6 (**TABLE**) to view the table of values.



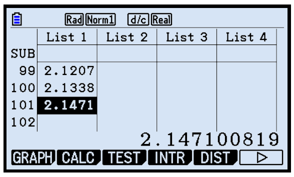
Press ▶ ▶ to highlight the first entry in the $\mathbf{b_{n+1}}$ column.

Press **OPTN** F1 (**LISTMEM**), then enter 1 **EXE** to save the values of $\mathbf{b_{n+1}}$ into **List 1**.



To view **List 1** press **MENU** and select **Statistics**.

Press ▲ until the 101st entry is shown.



So, $y(0.5) \approx 2.1471$.

CHAPTER 26 - EULER'S METHOD FOR COUPLED EQUATIONS

Casio fx-CG50

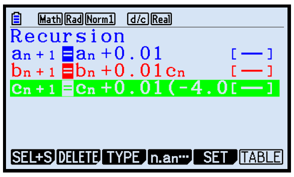
Consider the system of coupled differential equations $\begin{cases} \dfrac{dx}{dt} = y \\ \dfrac{dy}{dt} = -4.01x - 0.2y \end{cases}$ with $x(0) = 5$ and $y(0) = -0.5$.

To apply Euler's method with $h = 0.01$ for $0 \leqslant t \leqslant 5$, we have $t_0 = 0$, $x_0 = 5$, $y_0 = -0.5$, and

$$\begin{cases} t_i = t_{i-1} + h \\ x_i = x_{i-1} + hy_{i-1} \\ y_i = y_{i-1} + h(-4.01x_{i-1} - 0.2y_{i-1}). \end{cases}$$

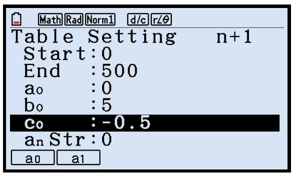
Select **Recursion** from the Main Menu, press F3 (**TYPE**), then F2 ($\mathbf{a_{n+1}}$).

Set up the screen as shown in the screenshots shown alongside.



Note: The formulae in $\mathbf{a_{n+1}}$, $\mathbf{b_{n+1}}$, and $\mathbf{c_{n+1}}$ correspond to the formulae for t_i, x_i, and y_i respectively.

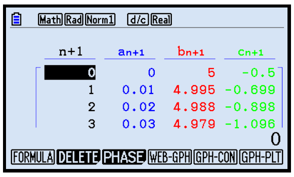
Press F5 (**SET**) and adjust the table settings.



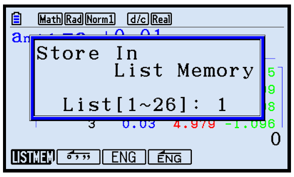
Set **Start** $= 0$, and **End** $= 500$ since we are taking $\frac{5}{0.01} = 500$ steps.

Set $\mathbf{a_0} = 0$ since $t_0 = 0$, $\mathbf{b_0} = 5$ since $x_0 = 5$, and $\mathbf{c_0} = -0.5$ since $y_0 = -0.5$.

Press F6 (**TABLE**) to generate a table of values.

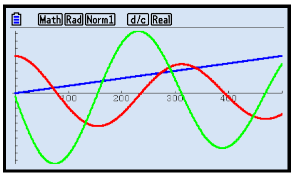


Save the values for t_i in **List 1** by highlighting any entry in column $\mathbf{a_{n+1}}$, pressing **OPTN** F1 (**LISTMEM**), then 1 **EXE**.



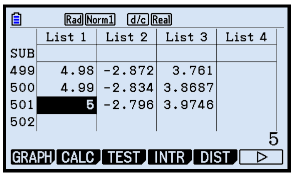
Save the values for x_i and y_i in **List 2** and **List 3** in a similar way.

Press **EXIT**, then F6 (**GPH-PLT**) to plot the values of t_i, x_i, and y_i.



Note: Press **SHIFT** F2 (**ZOOM**), then F5 (**AUTO**) to set an appropriate view window.

Press **MENU**, select **Statistics**, and press ▲ until the 501st entry appears.



Note: We want the 501st entry since we are taking $\frac{5}{0.01} = 500$ steps.

So, $x(5) \approx -2.80$ and $y(5) \approx 3.97$.

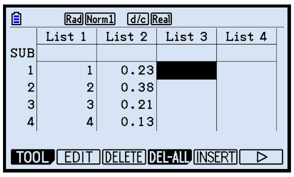
CHAPTER 27 - STANDARD DEVIATION OF A DISCRETE RANDOM VARIABLE

Casio fx-CG50

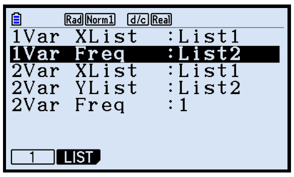
Find the standard deviation of the probability distribution alongside.

x_i	1	2	3	4	5
p_i	0.23	0.38	0.21	0.13	0.05

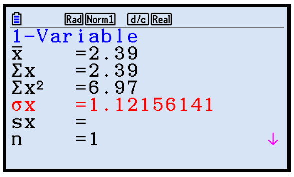
To find the standard deviation, first select **Statistics** from the Main Menu, enter the values for x_i into **List 1**, and the values for p_i into **List 2** as shown.



Press F6 (▷) until the **GRAPH** icon is in the bottom left corner of the screen, then press F2 (**CALC**), F6 (**SET**), and make sure the screen is set up as shown.



Press **EXIT**, then F1 (**1-VAR**) to view the statistics.



So, $\sigma \approx 1.12$.

CHAPTER 27 - MEAN AND STANDARD DEVIATION OF A DISCRETE RANDOM VARIABLE

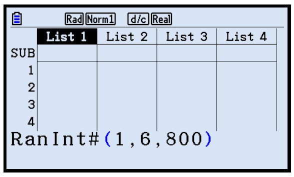
Casio fx-CG50

Calculate the mean and standard deviation of 800 randomly generated integers between 1 and 6.

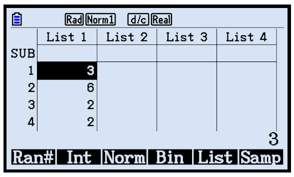
To generate random integers, use the **RandInt#** function.

First select **Statistics** from the Main Menu.

Move the cursor to highlight the header of **List 1** and press **OPTN** **F5** (**PROB**), **F4** (**RAND**), **F2** (**Int**), then 1 **,** 6 **,** 800 **)**.



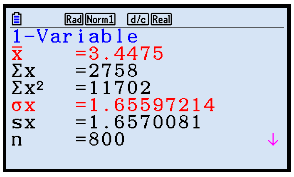
Press **EXE** to populate **List 1** with 800 random integers from 1 to 6.



Press **SHIFT** **EXIT** (**QUIT**), **F2** (**CALC**), **F6** (**SET**).

Set up the screen as shown alongside.

Press **EXIT**, then **F1** (**1-VAR**) to view the statistics.



So, $\mu \approx 3.45$ and $\sigma \approx 1.66$.

Note: Your values of μ and σ may not be exactly the same, but should be close (within ± 0.1).

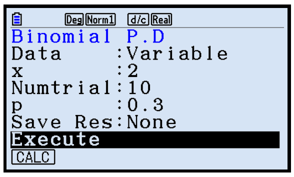
CHAPTER 27 - BINOMIAL PROBABILITIES

Casio fx-CG50

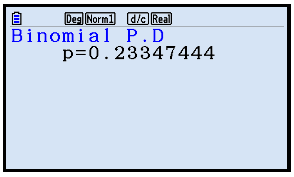
To find $\mathrm{P}(X = 2)$ for $X \sim \mathrm{B}(10, 0.3)$, select **Statistics** from the Main Menu.

Press F5 (**DIST**), F5 (**BINOMIAL**), then F1 (**Bpd**).

Set up the screen as shown, then press **EXE**.



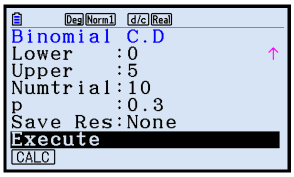
So, $\mathrm{P}(X = 2) \approx 0.233$.



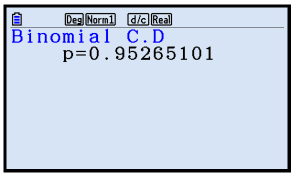
To find $\mathrm{P}(X \leqslant 5)$ for $X \sim \mathrm{B}(10, 0.3)$, select **Statistics** from the Main Menu.

Press F5 (**DIST**), F5 (**BINOMIAL**), then F2 (**Bcd**).

Set up the screen as shown, then press **EXE**.



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



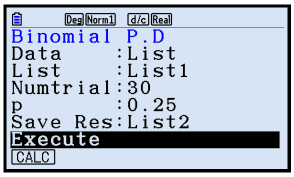
CHAPTER 27 - MEAN AND STANDARD DEVIATION OF A BINOMIAL DISTRIBUTION

Casio fx-CG50

Calculate the mean and standard deviation for the variable $X \sim \mathrm{B}(30, 0.25)$.

First enter the values $0, 1, ..., 30$ into **List 1**.

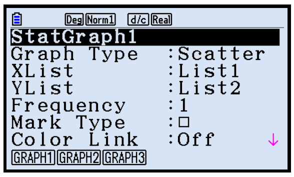
Press **F5** (**DIST**), **F5** (**BINOMIAL**), **F1** (**Bpd**), set up the screen as shown, then press **EXE**.



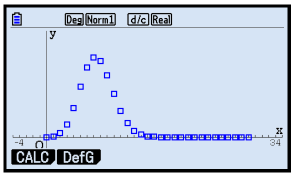
Note: This calculates $\mathrm{P}(X = x)$ for every value of x from 0 to 30, and saves the results in **List 2**.

Press **EXIT** to return to the List screen.

To draw a scatter plot of the data, press **F1** (**GRAPH**), **F6** (**SET**), and set up **StatGraph1** as shown.

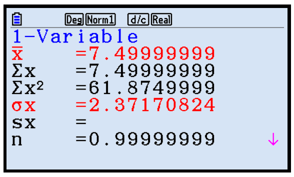


Press **EXIT**, then **F1** (**GRAPH1**) to draw the scatter plot.



To calculate the descriptive statistics, press **SHIFT** **EXIT** (**QUIT**), **F2** (**CALC**), **F6** (**SET**), and set up the screen as shown.

Press **EXIT**, then **F1** (**1-VAR**).



So, $\mu = 7.5$ and $\sigma \approx 2.3717$.

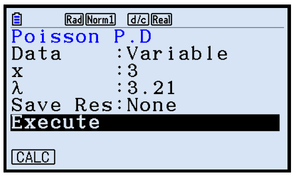
CHAPTER 27 - POISSON PROBABILITIES

Casio fx-CG50

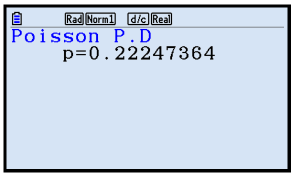
To find $\mathrm{P}(X = 3)$ for $X \sim \mathrm{Po}(3.21)$, select **Statistics** from the Main Menu.

Press F5 (**DIST**), F6 (▷), F1 (**Poisson**), then F1 (**Ppd**).

Set up the screen as shown, then press **EXE**.



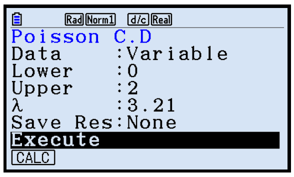
So, $\mathrm{P}(X = 3) \approx 0.222$.



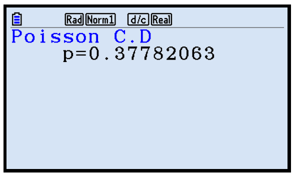
To find $\mathrm{P}(X \leqslant 2)$ for $X \sim \mathrm{Po}(3.21)$, select **Statistics** from the Main Menu.

Press F5 (**DIST**), F6 (▷), F1 (**Poisson**), then F2 (**Pcd**).

Set up the screen as shown, then press **EXE**.



So, $\mathrm{P}(X \leqslant 2) \approx 0.378$.



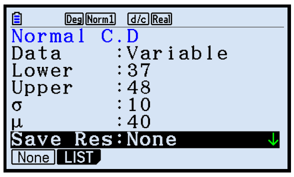
CHAPTER 28 - NORMAL PROBABILITIES

Casio fx-CG50

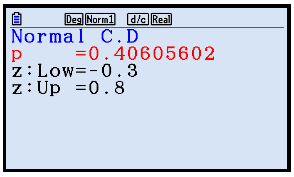
Suppose X is normally distributed with mean 40 and standard deviation 10.

To find $\mathrm{P}(37 < X < 48)$, first select **Statistics** from the Main Menu.

Press F5 (**DIST**), F1 (**NORM**), F2 (**Ncd**), and set up the screen as shown.



Scroll down to **Execute**, and press **EXE** to display the result.



So, $\mathrm{P}(37 < X < 48) \approx 0.406$.

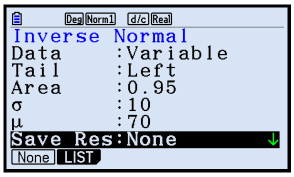
CHAPTER 28 - CALCULATING QUANTILES

Casio fx-CG50

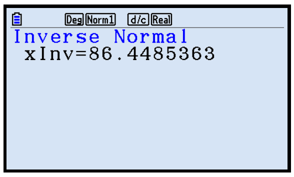
Suppose X is normally distributed with mean 70 and standard deviation 10.

To find k such that $\text{P}(X \leqslant k) = 0.95$, select **Statistics** from the Main Menu.

Press F5 (**DIST**), F1 (**NORM**), F3 (**InvN**), and set up the screen as shown.



Scroll down to **Execute**, and press **EXE** to display the result.



So, $k \approx 86.45$.

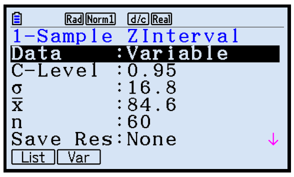
CHAPTER 29 - CONFIDENCE INTERVALS WITH KNOWN VARIANCE

Casio fx-CG50

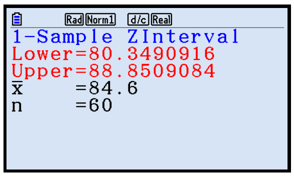
A sample of 60 yabbies was taken from a dam with sample mean weight of 84.6 grams. Given the population standard deviation is 16.8 grams, find a 95% confidence interval for the population mean μ.

First select **Statistics** from the Main Menu.

Press F4 (**INTR**), F1 (**Z**), F1 (**1-SAMPLE**), and set up the screen as shown alongside.



Scroll down to **Execute**, and press **EXE**.



So, the 95% confidence interval is $80.3 \leqslant \mu \leqslant 88.9$.

CHAPTER 29 - PROBABILITIES AND QUANTILES FOR THE t-DISTRIBUTION

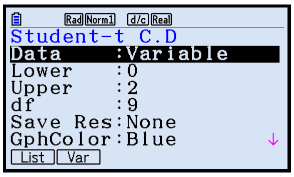
Casio fx-CG50

Suppose that $T \sim t_9$ so that T is a t-distribution with 9 degrees of freedom.

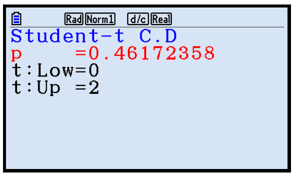
Probabilities

To calculate $\mathrm{P}(0 < T < 2)$, first select **Statistics** from the Main Menu.

Press F5 (**DIST**), F2 (**t**), F2 (**tcd**), and set up the screen as shown.



Scroll down to **Execute**, and press **EXE** to display the result.

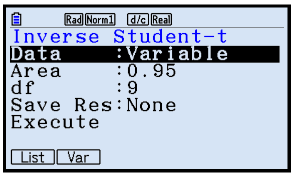


So, $\mathrm{P}(0 < T < 2) \approx 0.462$.

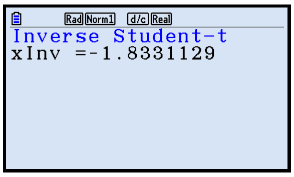
Quantiles

To find k such that $\mathrm{P}(T \geqslant k) = 0.95$, first select **Statistics** from the Main Menu.

Press F5 (**DIST**), F2 (**t**), F3 (**Invt**), and set up the screen as shown.



Scroll down to **Execute**, and press **EXE** to display the result.



So, $k \approx -1.83$.

Note: The **Casio fx-CG50** calculates the area of the *upper* tail of a t-distribution. So, for example, if you want to find k such that $\mathrm{P}(T \leqslant k) = 0.95$, instead find k such that $\mathrm{P}(T \geqslant k) = 1 - \mathrm{P}(T \leqslant k) = 0.05$.

CHAPTER 29 - CONFIDENCE INTERVALS WITH UNKNOWN VARIANCE

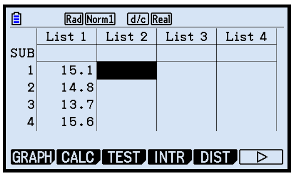
Casio fx-CG50

The sugar content, in grams, of 30 randomly selected loaves of bread at the local bakery was measured as follows.

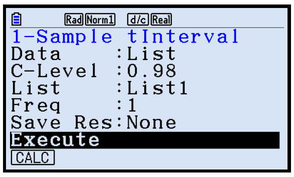
15.1	14.8	13.7	15.6	15.1	16.1	16.6	17.4	16.1	13.9	17.5	15.7	16.2	16.6	15.1
12.9	17.4	16.5	13.2	14.0	17.2	17.3	16.1	16.5	16.7	16.8	17.2	17.6	17.3	14.7

Determine a 98% confidence interval for the average sugar content μ of all loaves of bread baked.

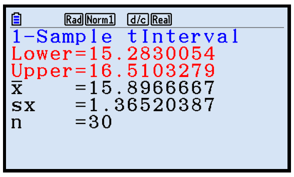
Select **Statistics** from the Main Menu, and store the data in **List 1**



Press F4 (**INTR**), F2 (**t**), F1 (**1-SAMPLE**), and set up the screen as shown alongside.



Scroll down to **Execute** and press EXE.



So, the 98% confidence interval is $15.28 \leqslant \mu \leqslant 16.51$.

Casio fx-CG50

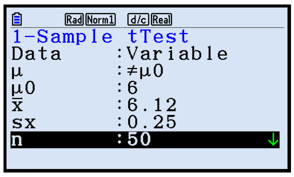
Statistics input

A researcher takes a random sample of 50 bottles of a new insect repellent, and finds that the mean protection time is $\bar{x} = 6.12$ hours, with standard deviation $s = 15$ minutes $= 0.25$ hours.

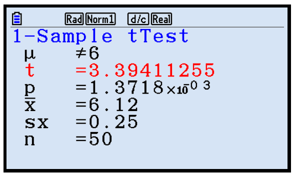
Calculate the test statistic t based on the hypotheses:

$H_0 : \mu = 6$ {the new product gives the same protection as the old ones}.
$H_1 : \mu \neq 6$ {the new product gives a different protection time compared with the old ones}.

First press **MENU**, select **Statistics**, then press F3 (**TEST**), F2 (**t**), and F1 (**1-SAMPLE**).



Set up the screen as shown, scroll down to **Execute**, and press **EXE** to display the test statistic.



So, $t \approx 3.39$.

Data input

A person's resting heartrate was measured at 9 am each day for a week. The results are shown in the table below:

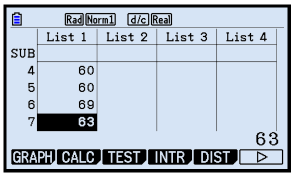
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
Heart rate (bpm)	64	58	59	60	60	69	63

Calculate the test statistic t based on the hypotheses:

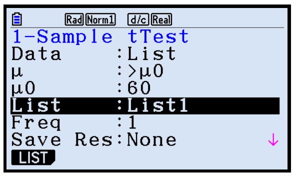
$H_0 : \mu = 60$ {the person's heart rate is 60 bpm}.
$H_1 : \mu > 60$ {the person's heart rate is greater than 60 bpm}.

First, press **MENU**, select **Statistics**, and enter the data in **List 1**.

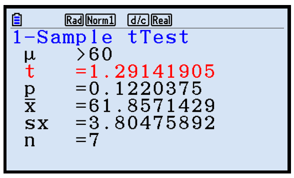
Press F3 (**TEST**), F2 (**t**), and F1 (**1-SAMPLE**).



Set up the screen as shown, scroll down to **Execute**, and press **EXE** to display the test statistic.



So, $t \approx 1.29$.



Casio fx-CG50

Calculating the t-statistic and p-value given sample statistics

A hypothesis test needs to be carried out to find out whether the *reduction* in cholesterol levels of patients using the old medication is less than the reduction in cholesterol levels of patients using the new medication at the 5% significance level. The results are shown below:

	Sample mean	*Sample standard deviation*
Old medication	0.351	0.058
New medication	0.497	0.077

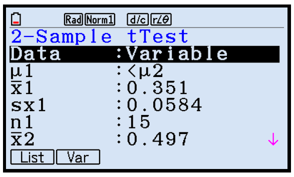
Step 1: Let μ_1 be the population mean reduction in cholesterol levels of the old medication, and μ_2 be that of the new medication.

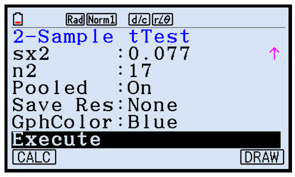
So, the hypotheses to be considered are: $H_0 : \mu_1 = \mu_2$, and $H_1 : \mu_1 < \mu_2$.

Step 2: The significance level is $\alpha = 0.05$.

Step 3: To calculate the test statistic and p-value, press **MENU** and select **Statistics**.

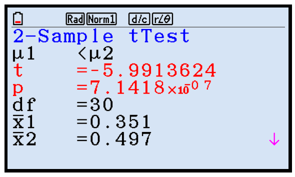
Next press **F3** (**TEST**), **F2** (**t**), then **F2** (**2-SAMPLE**), and set up the screen as shown.





Highlight **Execute**, press **EXE**, and the results will be displayed.

So, $t \approx -5.99$.



Step 4: From the screenshot, p-value $\approx 7.14 \times 10^{-7}$.

Step 5: Since p-value < 0.05, we have enough evidence to reject H_0 in favour of H_1 on a 5% significance level.

Step 6: We therefore accept H_1, and conclude that the new medication reduces cholesterol more than the old medication.

Calculating the t-statistic and p-value given data

We are given data from two samples X_1 and X_2, shown alongside, and asked to test if the population mean of X_1 is less than the population mean of X_2 at a 5% level of significance.

X_1	4	3	5	6	3	2		
X_2	6	7	6	6	4	7	8	10

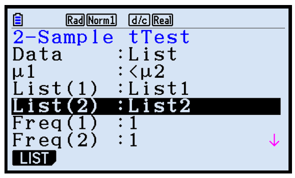
Step 1: Let μ_1 be the population mean of X_1, and μ_2 be the population mean of X_2.

So, the hypotheses to be considered are: $H_0 : \mu_1 = \mu_2$, and $H_1 : \mu_1 < \mu_2$.

Step 2: The significance level is $\alpha = 0.05$.

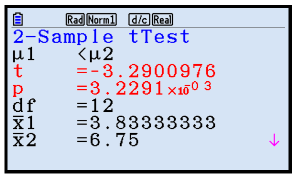
Step 3: To calculate the test statistic, first enter the data into **List 1** and **List 2**.

Open a 2-sample t-test as before, and set up the screen as shown to take data from lists. Make sure **Pooled** is still set to **On**.



Highlight **Execute** and press **EXE** to show the statistics.

So, $t \approx -3.29$.



Step 4: From the screenshot, p-value ≈ 0.00323.

Step 5: Since p-value < 0.05, we have enough evidence to reject H_0 in favour of H_1 at the 5% significance level.

Step 6: We therefore accept H_1, and conclude that $\mu_1 < \mu_2$.

CHAPTER 30 - HYPOTHESIS TESTING FOR ρ

Casio fx-CG50

Consider the bivariate dataset:

x	2	2	2	2	3	3	3	4	4	5
y	8	10	12	14	8	10	12	8	10	8

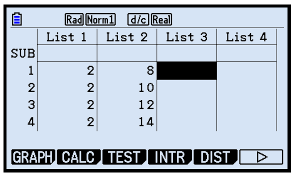
Conduct a hypothesis test at the 5% level of significance to determine whether the variables are negatively correlated.

Step 1: Let ρ be the population product moment correlation coefficient between the variables. We use the hypotheses:

$H_0 : \rho = 0$ {there is no correlation between the variables}
$H_1 : \rho < 0$ {the variables are negatively correlated}

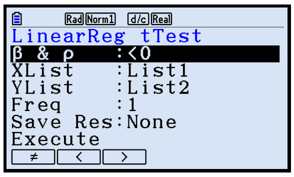
Step 2: The significance level is $\alpha = 0.05$.

Step 3: Select **Statistics** from the Main Menu, and enter the x-values into **List 1** and the y-values into **List 2**.

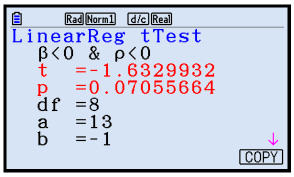


Press F3 (**TEST**), F2 (**t**), then F3 (**REG**) to perform a linear regression t-test.

We are testing the hypothesis that the variables are *negatively* correlated, so we press F2 ($<$) and set up the rest of the screen as shown.



Scroll down to **Execute** and press **EXE** to obtain the observed value and p-value of the test statistic.



The observed value of the test statistic ≈ -1.63.

Step 4: p-value ≈ 0.0706.

Step 5: Since p-value $> 0.05 = \alpha$, we do not have enough evidence to reject H_0 in favour of H_1 on a 5% significance level. We therefore accept H_0.

Step 6: Since we have accepted H_0, we conclude that the variables are not correlated.

CHAPTER 31 - THE χ^2 GOODNESS OF FIT TEST

Casio fx-CG50

To test a hypothesis about population proportions, a χ^2 goodness of fit test is carried out.

In this example we are given both the expected proportions of students' grades, and the actual distribution of results across $n = 151$ students with $\text{df} = 5 - 1$.

	Grade				
	HD	D	C	P	F
Number of Students	16	21	21	59	34
Expected Proportion	0.05	0.1	0.15	0.4	0.3

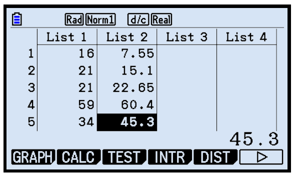
Step 1: The hypotheses to be considered are:

$H_0 : p_1 = 0.05,\ \ p_2 = 0.1,\ \ p_3 = 0.15,\ \ p_4 = 0.4,\ \text{ and }\ p_5 = 0.3\,.$

H_1 : At least one of these is not true.

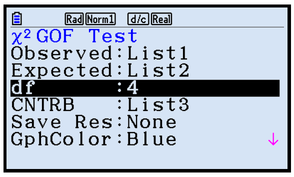
Step 2: The significance level is $\alpha = 0.05\,.$

Step 3: To calculate the test statistic and p-value, first enter the data into **List 1** and **List 2**, where **List 2** contains *Expected Proportion* $\times\, n$.

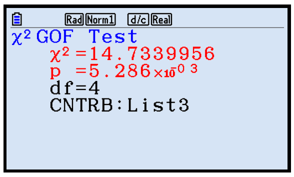


Press F3 (**TEST**), F3 (**CHI**), and F1 (**GOF**).

Set up the screen as shown, setting **df** to 4 as stated above.



Highlight **Execute**, press **EXE**, and the results will be displayed.



So, the test statistic $\chi^2 \approx 14.7\,.$

Step 4: p-value $\approx 0.00529\,.$

Step 5: Since p-value < 0.05, we have enough evidence to reject H_0 in favour of H_1 on a 5% significance level.

Step 6: We therefore accept that the course should be adjusted.

CHAPTER 31 - THE χ^2 TEST FOR INDEPENDENCE

Casio fx-CG50

Use a χ^2 test for independence to determine whether a student's *canteen preference* depends on their *year group* at a 5% level of significance.

Step 1: The hypotheses to be considered are:

H_0 : *year group* and *canteen preference* are independent.

H_1 : *year group* and *canteen preference* are not independent.

Step 2: The significance level is $\alpha = 0.05$.

Step 3: $\text{df} = (2-1)(4-1) = 3$.

Step 4: The contingency table and expected frequency table are given below.

Contingency table:

	Year group				
	9	10	11	12	*Sum*
C	7	9	13	14	43
C'	14	12	9	7	42
Sum	21	21	22	21	85

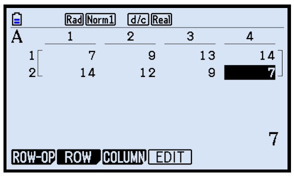
Expected frequency table:

	Year group			
	9	10	11	12
C	10.6	10.6	11.1	10.6
C'	10.4	10.4	10.9	10.4

Note: Only data from the contingency table is necessary to conduct the test on this calculator.

The expected frequency table is useful for checking the result later on.

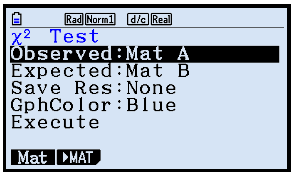
Press **MENU**, select **Run-Matrix**, then press F3 (**▶MAT/VCT**).



If **Mat A** is not set to **2×4**, press F3 (**DIM**), then set **m** = 2, **n** = 4, and press **EXE**.

Now enter the C and C' values from the contingency table into **A**, as shown on the screen.

Press **MENU**, select **Statistics**, then press F3 (**TEST**), F3 (**CHI**), F2 (**2WAY**).

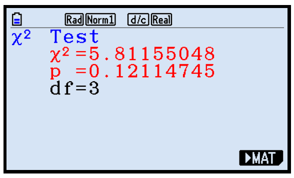


Ensure **Observed** is set to **Mat A**, and **Expected** is set to **Mat B**.

Note: If there is any data stored in **Mat B**, it will be overwritten.

Highlight **Execute**, press **EXE**, and the results will be displayed.

So, the test statistic $\chi^2 \approx 5.81$.



Step 5: p-value ≈ 0.121.

Step 6: Since p-value > 0.05, we do not have enough evidence to reject H_0 in favour of H_1 on a 5% significance level.

Step 7: We therefore accept H_0, and conclude that a student's *year group* and *canteen preference* are indepenent.

You can verify the result by comparing **Mat B** with the expected frequency table provided above.

From the **Run-Matrix** screen, press F3 (**▶MAT/VCT**), then select **Mat B**, and press **EXE**.