

HOW DO I ...

ON A CASIO

fx-8200AU



THE USEABLE MANUAL

Made in Australia

HOW DO I ... ON A CASIO fx-8200 AU
THE USABLE MANUAL

‘Boost your Curiosity’

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Questions about this publication should be directed to
edusupport@shriro.com.au

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This publication refers to the CASIO fx-8200 AU. This model description is registered.

Contents

1. Getting started

- 1.1 Getting ready to begin 4
- 1.2 Some first steps..... 5

2. Decimal, fractions and mixed numbers

- 2.1 Input and output settings 7
- 2.2 Displaying decimals – Fix and Norm 10
- 2.3 Entering and simplifying fractions 13
- 2.4 Fractions and decimals 14
- 2.5 Fractions and mixed numbers..... 16
- 2.6 Entering mixed numbers..... 17
- 2.7 Letter memories 18

3. Powers and roots

- 3.1 Powers 20
- 3.2 Square roots and other roots 22
- 3.3 Square roots – Pythagoras 24
- 3.4 A financial calculation..... 25
- 3.5 Logarithms..... 26

4. Statistics

- 4.1 Things to know 27
- 4.2 Entering, editing and deleting data 28
- 4.3 Five number summary 30
- 4.4 Mean and standard deviation..... 32
- 4.5 Linear Regression..... 34
- 4.6 Random numbers 36

5. Angles and trigonometry

- 5.1 Degrees, minutes and seconds 38
- 5.2 Trigonometric calculations 40
- 5.3 Scientific notation and ENG notation..... 42
- 5.4 Radians to degrees 43

6. Numbers

- 6.1 Lowest common multiple (LCM)..... 44
- 6.2 Greatest common divisor (GCD)..... 46
- 6.3 Prime factorisation..... 48
- 6.4 Verifying equality..... 49
- 6.5 Summation..... 51

7. Table

7.1 Making a table of values for a function	54
7.2 Solving an equation using table of values.....	56
7.3 Checking if two algebraic expressions are equal	58

8. Counting and probability


8.1 Factorials.....	60
8.2 Permutations.....	62
8.3 Combinations	63
8.4 Distribution – Normal	64
8.5 Distribution – Binomial	66

9. Complex numbers and vectors

9.1 Complex number calculations.....	68
9.2 Vector calculations.....	70

1.1 Getting ready to begin

Turn your calculator **ON**.

In the picture you can see a **SHIFT** key, . Pressing it allows you to use the **blue** functions *above* certain keys.

Note that this key does *not* work like a computer's Shift key. A calculator's Shift key is *pressed and released* and then the next button pressed.











In Section 1 we assume you have just taken the fx-8200 AU out of the box and have not changed any of the out-of-the-box (factory/default) settings.

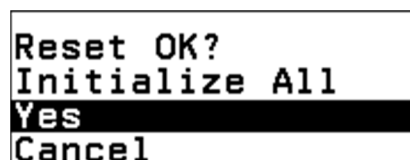


If your calculator is *not* out-of-the-box, then we suggest you *initialise* it, which returns all the settings back to the factory settings.

With the  selected, press  to launch the Calculate application.

To initialise, press:

-  to open the settings,
-   to select **Reset** ,
-    to select **Intialize All** ,
-  to select Yes,
-  to reset the calculator.



The HOME screen will then be displayed and the Calculate application will be selected.



 to launch the Calculate application.



You are now ready to start!

1.2 Some first steps

An almost empty screen awaits you.

Notice the **flashing cursor** to the left of screen. This signifies the calculator is ready for you to enter a calculation.



Let's calculate $325 \div 30$.

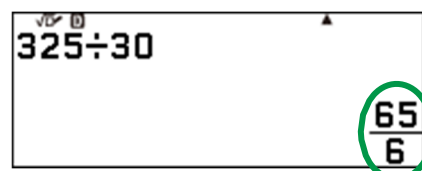
Enter:

3 2 5

\div

3 0

EXE

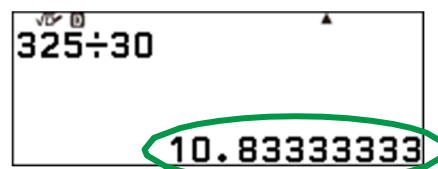


The result in **fractional form**, $\frac{65}{6}$, is shown on the **right side** (the output side) of the screen.

Note the fraction is in simplified form.

To see the **decimal approximation** of the result, press:

\uparrow then EXE (to access \approx).



Press AC. This clears the screen.

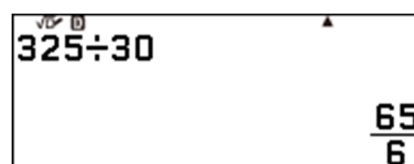
Notice the **small arrow pointing upwards**.

This indicates that the calculator has stored the previous calculation.



Press \uparrow (the cursor key above OK).

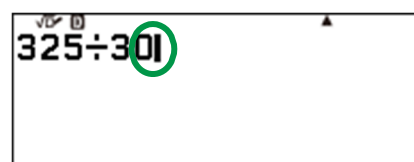
The previous calculation is recalled.



Suppose we wanted to calculate $325 \div 35$.

Press $\rightarrow \rightarrow \rightarrow \rightarrow \rightarrow \rightarrow \rightarrow$ to move the cursor to the **right** of the 0.

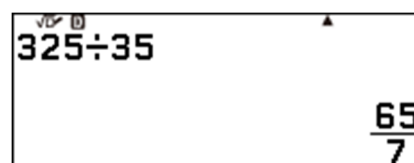
(Or press \leftarrow .)



Press \times to remove the 0 and then press

5 then EXE.

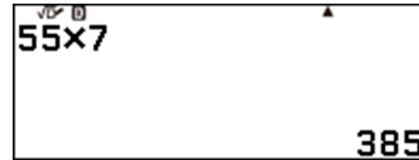
What do you think $325 \div 40$ will be?



John owns a one-man gardening business. Every time he does a job, he calculates the amount he is owed by multiplying the number of hours worked by \$55 and then adds 15% to this figure to cover his health cover and other similar things.

If he completed a job that took 7 hours, how much would he be owed?

First calculate 55×7 .



385 will now be stored in the *answer memory*.

Now let's find the 'extra' that John adds to this.
Enter:

- 1 5
- $\frac{\square}{\square}$ \checkmark to select **Probability**
- OK** to select **%**
- OK**
- \times **Ans**
- EXE**



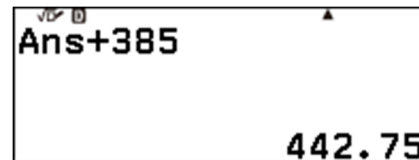
To see the decimal form of this result press:

- FORMAT** \checkmark to select **Decimal**
- OK**



Now we need to add \$57.75 to \$385.
We can use the answer memory again. Enter:

- Ans**
- +** 3 8 5



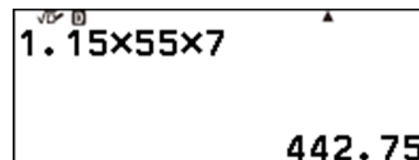
To get the decimal form of the answer directly,
press:

- \uparrow then **EXE** (to access \approx).

Alternatively, we could have calculated
115% of 55×7 .


Enter:

- 1 . 1 5 \times 5 5 \times 7
- \uparrow then **EXE** (to access \approx).



Ah, the same result!

2.1 Input and output settings

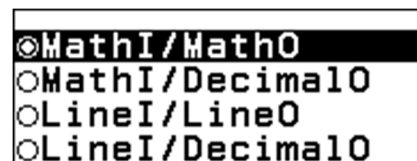
When using the  application, you supply an *input* and the calculator supplies an *output*. Imagine you supplied the input $4 \times \frac{7}{3}$. Should the calculator supply the output,

- $\frac{28}{3}$ or
- 9.333333333.

You can ensure you get the form of output you want by choosing the appropriate Input/Output setting.

This calculator has four Input/Output settings:

1. MathI / MathO,
2. MathI / DecimalO,
3. LineI / LineO,
4. LineI / DecimalO.



MathI/MathO

MathI/MathO allows you to use the nice templates that support *natural display input*, meaning that you can enter a calculation as you would write it on a piece of paper. This setting supplies outputs in what is called Standard form.

Standard form is usually the form of a number that is *not* a decimal.

Some examples are:

- fractional form,
- surd form,
- in terms of π .

If you supply the input:

- $4 \times \frac{7}{3}$, the output is $\frac{28}{3}$,
- $\sqrt{2} \times \sqrt{10}$, the output is $2\sqrt{5}$,
- $\sin^{-1}\left(\frac{\sqrt{3}}{2}\right)$, and the angle unit is set to radians, the output is $\frac{1}{3}\pi$.

MathI / DecimalO




MathI / DecimalO allows you to use the nice templates that support *natural display input* but supplies outputs in Decimal form.

If you supply the input:

- $4 \times \frac{7}{3}$, the output is 9.333333333 ,
- $\sqrt{2} \times \sqrt{10}$, the output is 4.472135955,
- $\sin^{-1}\left(\frac{\sqrt{3}}{2}\right)$, and the angle unit is set to radians, the output is 1.047197551.

Suppose you want Decimal outputs.

You can change the Input/Output setting to MathI/DecimalO, and check it works, by doing the following:

From the  screen, launch the Calculate application by selecting  and pressing .

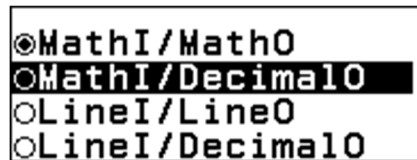



Press:

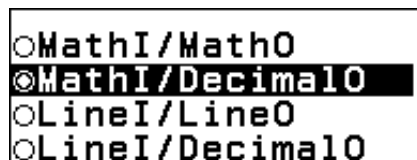
 to select **Calc Settings** .


 to select **Input/Output** .

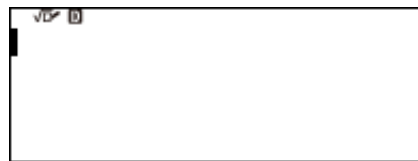
  to select **MathI/DecimalO**.



 to choose the MathI/DecimalO setting.

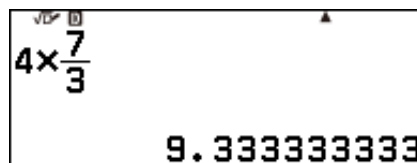


 to return to the calculation screen.



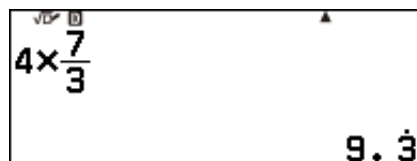
Enter:

You can see the recurring decimal form of 9.333333333 by pressing:

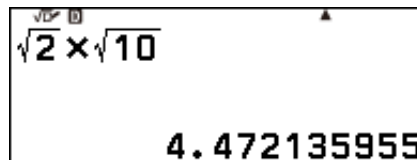
   to select **Recurring Decimal**

Enter:


Now change the Input/Output setting to MathI/MathO, and check it works, by doing the following:

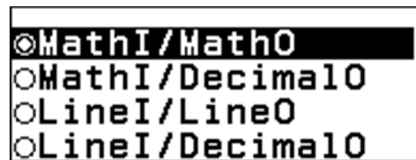
 to select **Calc Settings** ▶,


 to select **Input/Output** ▶,

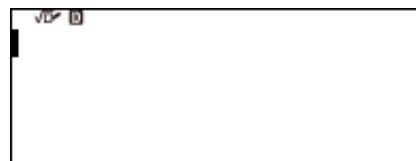
 to select MathI/MathO.



 to choose the MathI/MathO setting.



 to return to the calculation screen.









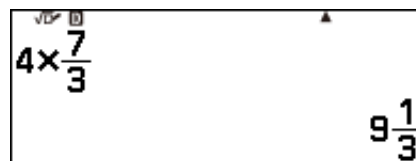
Enter:




You can see the mixed number form of $\frac{28}{3}$ by pressing:

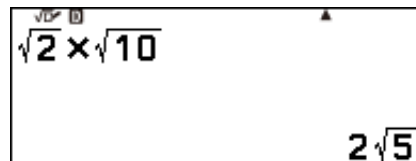
     to select **Mixed Fraction**




Enter:

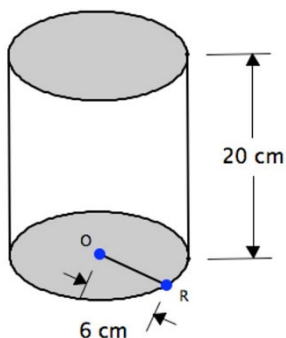
  

2.2 Displaying decimals – Fix and Norm

Set your calculator to MathI/DecimalO, so outputs are displayed in Decimal form. See section 2.1.

Many of the calculations you do will require a decimal approximation for a quantity. For example, suppose a cylindrical oil tank is to be made for a racing car. The tank has base radius of 6 cm, height of 20 cm and is made of aluminium.



Calculate the area of the circular base of the tank, and its volume, correct to 2 decimal places.

We know that $A_c = \pi r^2$

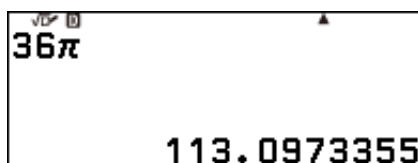
So in this case $A_c = \pi \times 6^2$

$$= 36\pi$$



$$\approx 108\text{cm}^2 \text{ (estimated mentally)}$$

Let's use the calculator to gain a little more accuracy.

From the  screen, launch the  application.



 then  (to access π)



Note that 10 digits are displayed.







We require 2 decimal place accuracy.

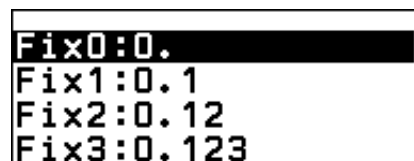
So, the area is 113.10 cm^2 .




We could set the calculator to display the answer to this level of accuracy automatically.

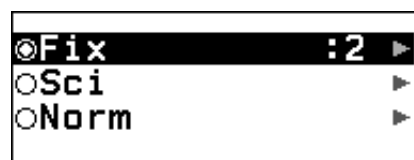
This can be done in the SETTINGS menu.


Press:

-  to select **Calc Settings** ▶,
-    to select **Number Format** ▶,
-  to select **Fix** ▶,
-  to see the options.

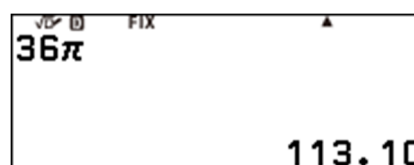


-    to choose two-decimal place accuracy.



-   to re-calculate the result.

Note that in this setting the result is rounded correct to 2 decimal places, not truncated.



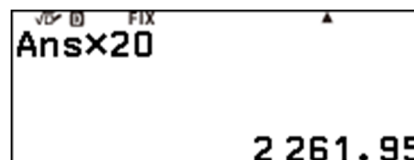
Most importantly though, Fix is a display feature, the calculator has still stored the 10 digit value.

To calculate the volume, we do *not* want to use the rounded figure. We want to use the most accurate value we have – the one with all the decimal places.

We can use the *answer* memory to our advantage:

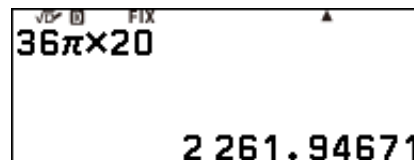
-    
- 

which gives us the volume of the tank, 2261.95 cm³ rounded to two decimal places.








Note that 113.10 was not used in the calculation, 113.0973355 was, since $113.10 \times 20 = 2262$.

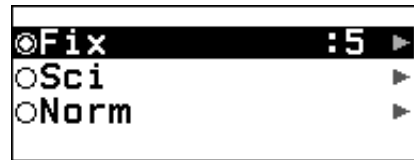
We can display more digits using the Fix option again.



There are a series of different settings you can choose with respect to the display of numbers.

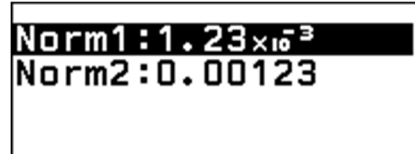
Press:

-  to select **Calc Settings** ▶,
-    to select **Number Format** ▶,
-  to see the options.



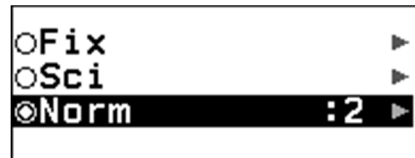
To return to the default setting, Norm2, press:

to select **Norm**,
 to see the options.



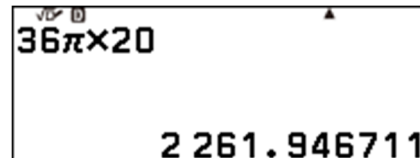
Norm1: 1.23×10^{-3}
Norm2: 0.00123

to choose Norm2.



Fix
 Sci
 Norm :2

to return to the calculation screen.
 to recalculate.



$36\pi \times 20$
2261.946711

For general calculations there are two Norm settings, Norm1 and Norm2.

One difference between them is that Norm1 displays positive numbers smaller than 0.01 in scientific notation, whereas Norm2 displays positive numbers smaller than 0.000000001 in scientific notation.

For most purposes Norm2 is the most useful display, and is the factory setting (restored upon initialisation).

Unless otherwise stated, Norm2 is the setting used in calculations from this point onwards.

2.3 Entering and simplifying fractions

Set your calculator to MathI/MathO, so outputs are displayed in Standard form. See section 2.1.

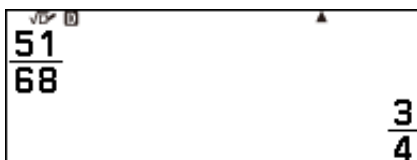
The fraction $\frac{51}{68}$ can be thought of as 51 parts of 68 equal parts of some whole. Is there a simpler way to think about this fraction?

From the  screen, launch the  application.



Enter   then .

Note that a fraction *template* appears and the cursor is flashing in the denominator waiting for you to enter the 68.



Enter   and then press .

The calculator simplifies the fraction, dividing numerator and denominator by 17. Do you know your 17 times table?




Simplify $\frac{867}{68}$.

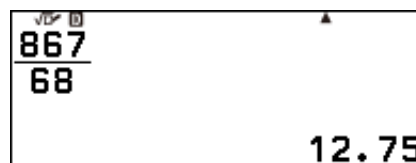







 

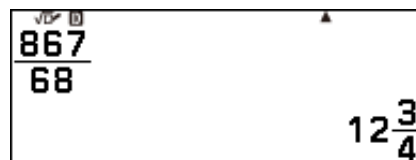

To see the decimal form of this result press:

  to select **Decimal**




To see the result as a mixed number, press:

    to select **Mixed Fraction**




2.4 Fractions and decimals

A fraction is the exact value of a quantity. For example, we know that $\frac{6}{33} + \frac{5}{33}$ is exactly equal to $\frac{11}{33} = \frac{1}{3}$ and that the decimal 0.333 (correct to 3 decimal places) is an approximation for $\frac{1}{3}$.

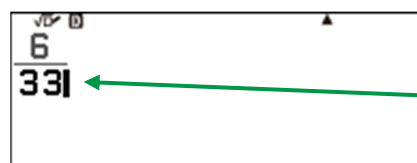
Let's see how the fx-8200 AU deals with fraction calculations.

Calculate $\frac{6}{33} + \frac{5}{33}$ on the calculator. The fraction key will be used for entry.



Enter $\textcircled{6}$ then $\textcircled{\frac{\square}{\square}}$.

Note that the fraction appears and the cursor is flashing in the denominator waiting for you to enter the 33.

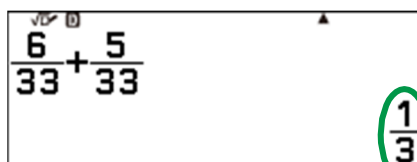


Enter $\textcircled{3}$ $\textcircled{3}$.

Note that the **cursor is still in the denominator** and we need it to be *outside and to the right* of the fraction to continue.

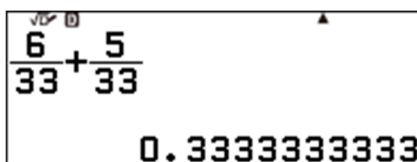


Press $\textcircled{\rightarrow}$ to position the cursor as shown.

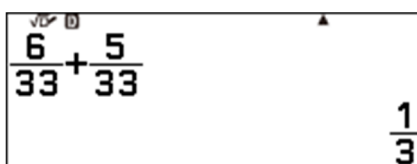


Enter $\textcircled{+}$ $\textcircled{5}$ $\textcircled{\frac{\square}{\square}}$ $\textcircled{3}$ $\textcircled{3}$ $\textcircled{\text{EXE}}$.

$\frac{11}{33}$ is displayed in **simplified form**, $\frac{1}{3}$.

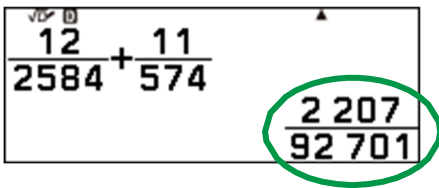


To get the decimal form of the answer, press $\textcircled{\uparrow}$ then $\textcircled{\text{EXE}}$ (to access \approx).



Press $\textcircled{\text{EXE}}$ again to return to the fraction.

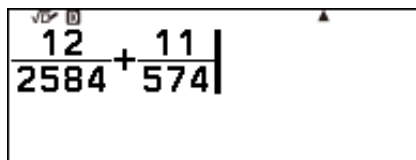
Calculate $\frac{12}{2584} + \frac{11}{574}$.



A calculator display showing the fraction $\frac{12}{2584} + \frac{11}{574}$ on the top line and the result $\frac{2207}{92701}$ on the bottom line. The fraction $\frac{2207}{92701}$ is circled in green.

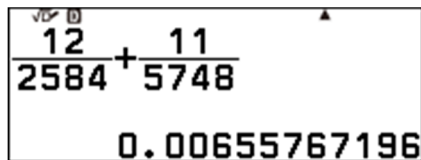
Even in this case, a **fractional output** is given!
This one would be a challenge using mind alone.

Calculate $\frac{12}{2584} + \frac{11}{5748}$.



A calculator display showing the fraction $\frac{12}{2584} + \frac{11}{5748}$ on the top line. A vertical cursor is positioned at the end of the input line.

Press \leftarrow and note that the cursor is at the end of the input line.



A calculator display showing the fraction $\frac{12}{2584} + \frac{11}{5748}$ on the top line and the decimal result 0.00655767196 on the bottom line.

Press \leftarrow again and then press 8 EXE .

No fraction this time, rather a decimal approximation. Interesting! Why does this happen? It happens because the calculator has a limit to what it can display as a fraction. The limit is 10 characters made up from the numerator, denominator and the vinculum.

2.5 Fractions and mixed numbers

You have now seen a little of how the calculator works with fractions. Let's explore some more.

Convert $\frac{217}{15}$ to a mixed number.



Enter $\frac{217}{15}$ and press **EXE**.

This process simply stores the fraction in the answer memory.



To see the result as a mixed number, press:

FORMAT **▼** **▼** **▼** **▼** to select **Mixed Fraction**
EXE

If you press **EXE** again, the result will be shown as an improper fraction.

The calculator's default setting is to display an output as a fraction (proper or improper) as opposed to a mixed number. This setting can be changed so the default display is a mixed number.

This can be done in the **SETTINGS** menu.

Press:

≡ to select **Calc Settings** **▶**,
OK **▼** **▼** **▼** to select **Fraction Result** **▶**,
OK to see the options.

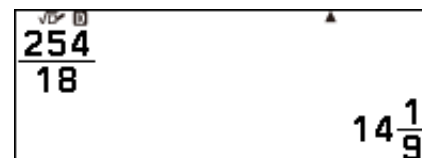


OK to choose Mixed Fraction.



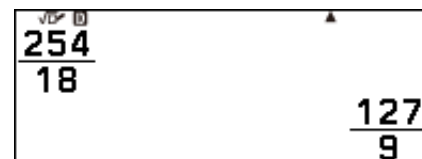
Now enter **2** **5** **4** **□** **1** **8**

Press **EXE** for the result to be shown as a mixed number.



To see $14\frac{1}{9}$ as an improper fraction, press:

FORMAT **▼** **▼** **▼** to select **Improper Fraction**
OK



2.6 Entering mixed numbers

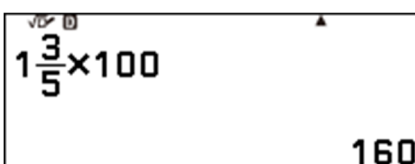
Calculate $1\frac{3}{5} \times 100$ on the calculator.



Press \uparrow then $\frac{\square}{\square}$ (to access $\frac{\square}{\square}$).
This enters a mixed number template.
The cursor is flashing in the non-fraction part.



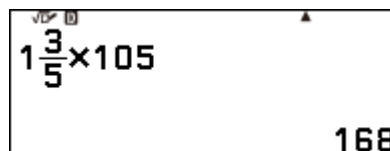
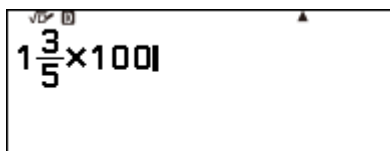
Enter:
 $\odot 1 \odot > \odot 3 \odot \vee \odot 5$



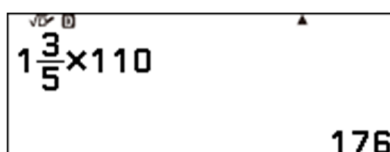
Now enter:
 $\odot > \odot \times \odot 1 \odot 0 \odot 0$
 $\odot \text{EXE}$

Now calculate $1\frac{3}{5} \times 105$ and $1\frac{3}{5} \times 110$.

Press \leftarrow to position the cursor to the right of 100 and press \times $\odot 5$ EXE .



Then, \leftarrow \times \times $\odot 1$ $\odot 0$ EXE .



Can you predict what $1\frac{3}{5} \times 115$ will be? What about $1\frac{3}{5} \times 120$?

Can you explain why this works?

If $2\frac{3}{5} \times 100 = 260$, what do you think $2\frac{3}{5} \times 105$ equals? Check it out.

2.7 Letter memories

Look at the nine keys on the bottom-left of the keyboard.
A little above-left of each key you will see a blue letter.



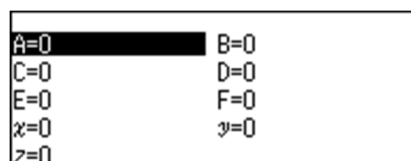
Each letter, A, B, C, D, E, F, x, y and z, can take the place of a previously stored numerical value in a calculation.

From the HOME () screen, launch the Calculate application by selecting

and pressing .

Press (VARIABLE).

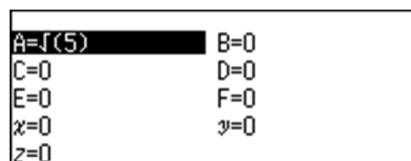
You can see the default situation is that the stored value for each letter is 0.



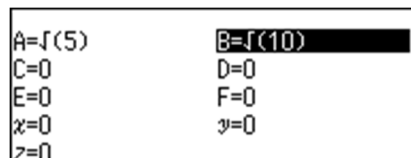
Press , to prepare to store $\sqrt{5}$ as the value of A.



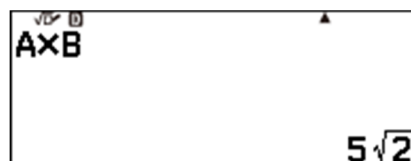
Press to store the value and return to the memory list.



To store $\sqrt{10}$ as the value of B, press:



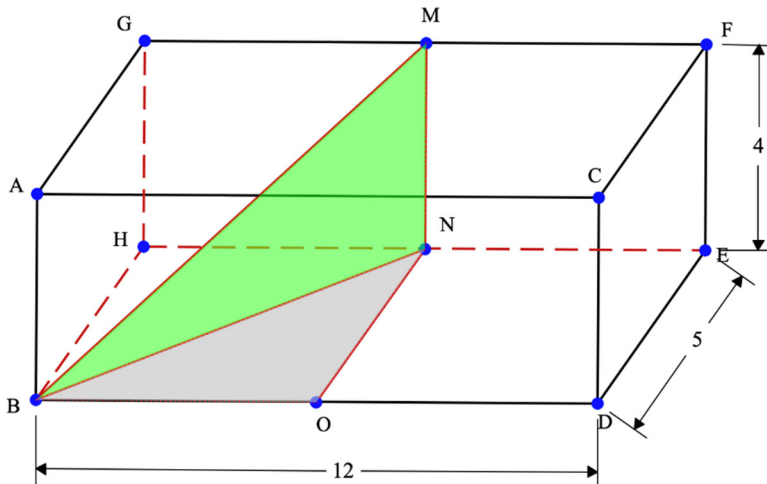
To calculate $A \times B$, press:



In the rectangular prism below, M is the midpoint of GF, N is the midpoint of HE and O is the midpoint of BD. Dimensions are measured in metres.

What is the difference between the size of angle NBO and the size of angle MBN?

Provide your answer correct to 4 decimal places.



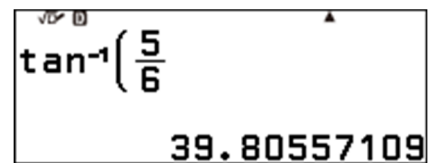
Angle BON and angle BNM are right angles, so both the grey triangle and the green triangle are right-angled triangles. Therefore, we can use trigonometric ratios and Pythagoras' Theorem to answer this question.

We should not round the interim answers that we calculate before calculating the difference that is required. Otherwise, a *rounding error* may occur. We can use the memories to help us be accurate.

To find the size of angle NBO press:

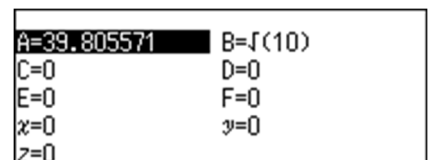
\uparrow (tan) 5 (6) (EXE)

Note: If brackets are not mathematically required, they can be left out.



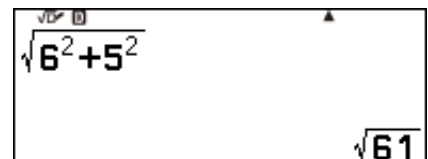
To store this value as A press:

(2nd) (Ans) (EXE)



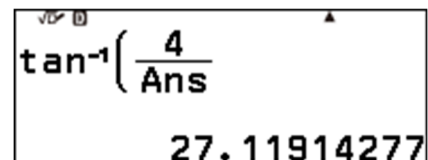
To find the length of BN, press:

(AC) (sqrt) 6 (5) (sqrt) (EXE)



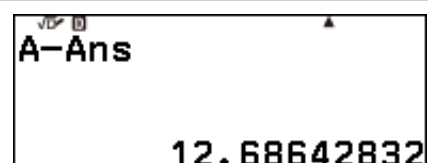
To find the size of angle MBN press:

\uparrow (tan) 4 (Ans) (EXE)



To calculate the difference between the angles press:

\uparrow 4 (-) (Ans) (EXE)



So, the answer required is 12.6864°.

3.1 Powers

What is a power of 5?

125 is a power of 5. It is actually the 3rd power of 5 because $5 \times 5 \times 5 = 125$ or 5^3 (pronounced '5 to the 3') = 125.


When we write $5^3 = 125$, the number 5 is called the *base* and 3 is called the *exponent* (also known as a logarithm).

$2^6 = 64$. So, we say 64 is the 6th power of 2.


Calculate the following:


- a) the 8th power of 3 c) 4^6 e) 7^7
 b) the 4th power of 9 d) 16^3 f) 7×49^3

From the  screen, launch the  application.




3⁸ 6 561


③  ⑧ EXE




9⁴ 6 561


⑨  ④ EXE

What? $3^8 = 9^4$, how can that be?




4⁶ 4 096

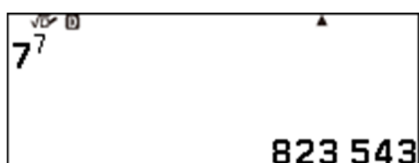
④  ⑥ EXE




16³ 4 096

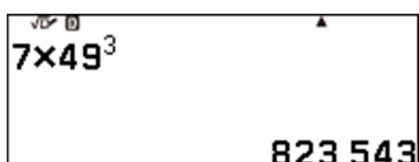
① ⑥  ③ EXE

What? $4^6 = 16^3$, how can that be?





7⁷ 823 543

⑦  ⑦ EXE



7x49³ 823 543

⑦  ④ ⑨  ③ EXE

What? $7^7 = 7 \times 49^3$, how can that be?
 Is $2^{20} = 4 \times 8^6$? If so, try to work out why.

A famous tale tells that the inventor of Chess made his king so happy he was offered a prize of his naming for the work he had done. He asked for 1 grain of wheat for the first square of the board and then double that for the second and double that for the third and ...
Let's calculate the amount for each square.

Start by entering ① and pressing EXE.

This stores 1 in the *answer memory*.



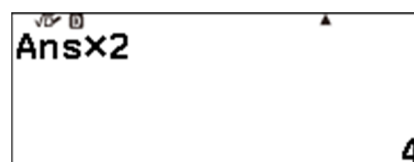
Now press \times ② EXE.

Note the input reads: **answer** multiplied by 2.



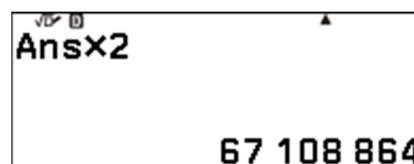
Now press EXE.

You can see we now have a recursive process going.



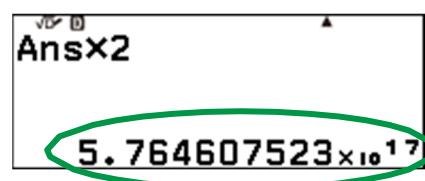
Press EXE, EXE, EXE, ...

I have pressed it quite a few times in the screen opposite.



If you forget how many presses you have made, you can press the \wedge arrow to go backwards and then use the \vee to go forwards.

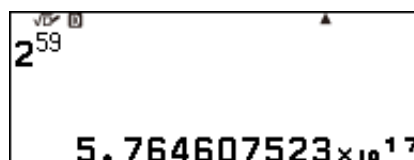
The screen opposite shows **how many grains** I think he got for the 60th square; do you agree?
Note that $5.764607523 \times 10^{17}$ means 5764607523???????? (the ?s are unknown digits).
The decimal point is moved 17 places to the right.
This calculator can display no more than 10 digits.



Another way to calculate this would be to find 2^{59} .

Enter ② \square ⑤ ⑨ EXE.

How many wheat grains in total would he have had? See if you can find out how to work that out. (There are 64 squares on a chess board.)



3.2 Square roots and other roots

I bet you have heard of a square root, e.g. $\sqrt{64} = 8$.

The square root of a number, k , is the positive number, j , which when multiplied by itself, gives the number k . If j is an integer, then k is called a *perfect square*.

If $k = 25$, then $j = 5$. But if $k = 26$, what will j equal?

As well as square roots there are cubed roots, 4th roots, 5th roots,, n^{th} roots.

Calculate the value of each of the following:

a) $\sqrt{649536196}$

c) $\sqrt{18}$

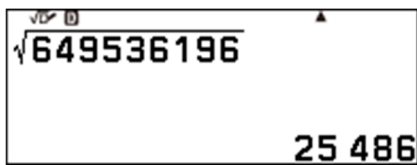
e) $\sqrt{64 \times 10001}$

b) $\sqrt{10001}$

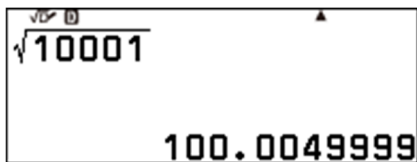
d) $\sqrt{100 \times 31}$

f) $\sqrt[3]{64}$

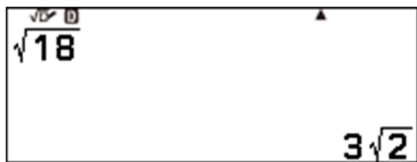
From the  screen, launch the  application.



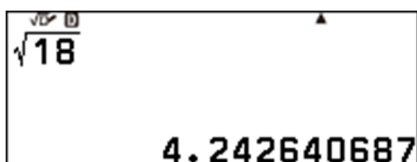
So, 649536196 is a perfect square.
I bet you did not know that!





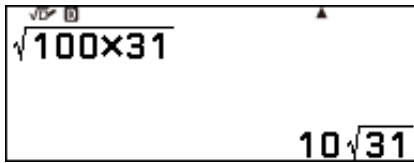
So close to a perfect square, but not close enough.
Numbers like $\sqrt{10001}$ are called *surd*s.



The surd, $\sqrt{18}$, has been simplified.
If k has a perfect square factor, 9 in this case, the surd can be simplified.

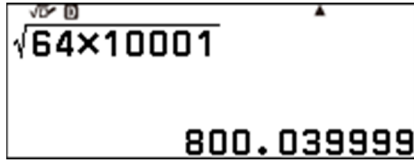


To calculate the decimal approximation of $\sqrt{18}$, press  then  (to access \approx).



$\sqrt{\square}$
① ① ① ① × ③ ①
EXE

So $\sqrt{3100} = 10\sqrt{31}$.



$\sqrt{\square}$
⑥ ④ × ① ① ① ① ①
EXE

The calculator cannot simplify all surds that can be simplified.

$\sqrt{640064} = 8\sqrt{10001}$, but the calculator does not know this, and so returns a decimal approximation.

If k is too large, a decimal approximation will be returned. How large is too large?

See if you can find out.

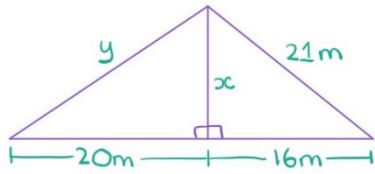


$\sqrt[3]{\square}$ – to enter $\sqrt[3]{\square}$
③
>
⑥ ④
EXE

64 is not only a perfect square, but a perfect cube as well. Is it a perfect *anything else*?

3.3 Square roots – Pythagoras

Suppose we need to determine the lengths of the currently unknown sides in the construction shown below. We could begin as follows:



$$c^2 = a^2 + b^2$$

$$\Rightarrow 21^2 = 16^2 + x^2$$

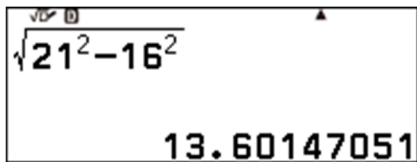
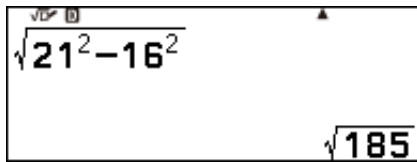
$$\Rightarrow x = \sqrt{21^2 - 16^2}$$

$$y^2 = 20^2 + x^2$$

$$\Rightarrow y = \sqrt{20^2 + x^2}$$

To determine the values of x and y , we can do the following.

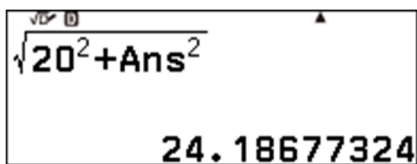
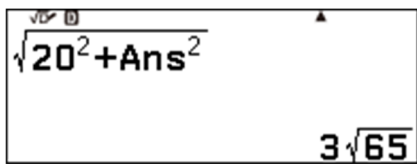
From the screen, launch the **Calculate** application.



We can also calculate a decimal approximation for x .

Press then (to access \approx).

The output is stored in the answer memory and so we can use it to calculate the value of y .



To calculate a decimal approximation for y , press then (to access \approx).

So, we know that $x = \sqrt{185} \text{ m} \approx 13.6 \text{ m}$ and that $y = 3\sqrt{65} \text{ m} \approx 24.2 \text{ m}$ (correct to 1 decimal place).

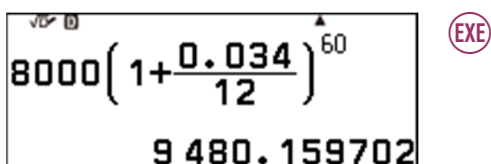
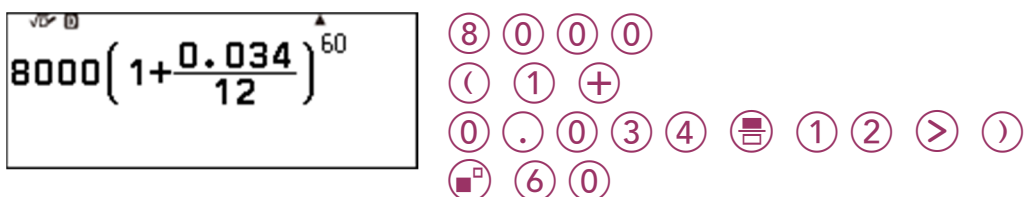
3.4 A financial calculation

Suppose we wish to calculate the value of an investment of \$8000, five years after investing it in an account that pays interest of 3.4% p.a. compounded monthly. We can use the formula:

$$A = P \left(1 + \frac{r}{100} \right)^n$$

Calculate $8000 \left(1 + \frac{0.034}{12} \right)^{60}$ on your calculator.







From the  screen, launch the  application.

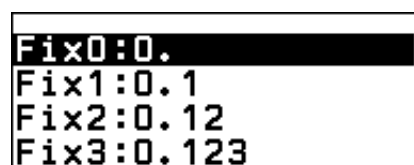





It is possible to set the calculator to display the result correct to two decimal places.

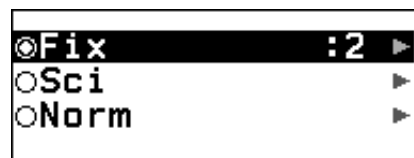
This can be done in the SETTINGS menu.

Press:

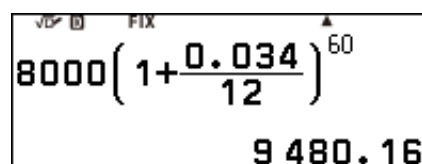
-  to select **Calc Settings** ▶,
-    to select **Number Format** ▶,
-  to select **Fix** ▶,
-  to see the options.



-    to choose two-decimal place accuracy.



-   to re-calculate the result.



Note: Now set your calculator to Norm 2.
You can learn more about the Norm display setting in section 2.2.

3.5 Logarithms

In section 3.1 we looked at powers.

For example, since $64 = 2^6$, we say that 64 is the 6th power of 2.

Do you recall the name given to the number 6, in the equality $64 = 2^6$? It is called a *logarithm*. (It is also called an index or an exponent.)

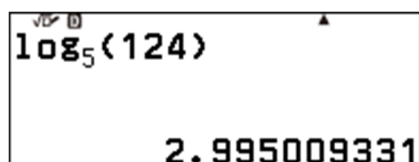
Consider the equation $5^x = 124$. What is the value of x ?

x is the value to which 5 is raised to get 124.

You probably know $x \approx 3$. Actually, a little less than 3.

To be precise $x = \log_5(124)$, the decimal approximation of which can be calculated as follows.

From the  screen, launch the  application.

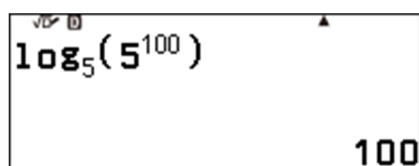


Just under 3, as expected.

Predict the value of each of the following and then calculate them to determine the quality of your predictions.

- a) $\log_4(64)$ b) $\log_3(82)$ c) $\log_2(256)$ d) $\log_8(1)$

What is the value of $\log_5(5^{100})$?



What is going on here?

Can you explain why $\log_5(5^{100}) = 100$?

What do you think $\log_a(a^b)$ is equal to?

One last thing before we finish. What do you think $\log_6\left(\frac{1}{36}\right)$ is equal to?

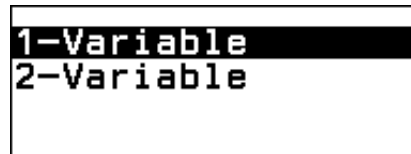
4.1 Things to know

When working with data, you need to select the Statistics application. It is also suggested that you set it to display the Frequency of each score.


From the  screen, launch the



application.



In this application, you can work with univariate or bivariate data.

For this task, select **1-Variable** and then press  to open the data list.



Note: If a Frequency column is showing on your calculator, you do not need to proceed.

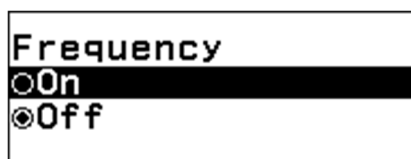
To display the Frequency column, press



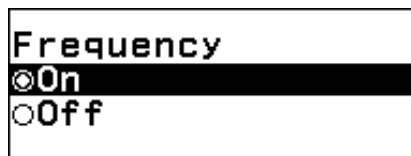
to select **Frequency**,



to open the Frequency settings.



Press  to turn the Frequency setting on.



Now press  to return to the data lists.



How many rows of data can be entered?

This is dependant on the number of columns displayed in the Statstics editor.

One column (single variable, x) = 160 rows.

Two columns (single variable, x + Freq) or (paired variable data x, y) = 80 rows.

Three columns (paired variable data x, y + Freq) = 53 rows.

4.2 Entering, editing and deleting data

Before doing this section, be sure you have carried out the directions in the previous section.

Below are the weights (in grams) of the last 10 tomatoes I picked.

54, 68, 45, 55, 64, 80, 52, 63, 72, 71.

Enter these data into the Statistics application of your calculator.


From the  screen, launch the

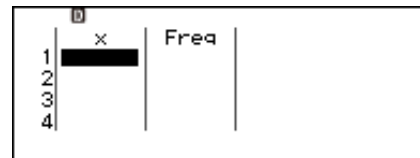


application.



Select **1-Variable** and then press

 to open the data list.



Note 1:

You may be asked if you wish to clear data. This will happen if you have data in the 2-Variable section.

You must choose **Yes** if you want to proceed.

Note 2:

If data already exists in the lists, delete it – see the instructions on the bottom of page 29.


Note 3:

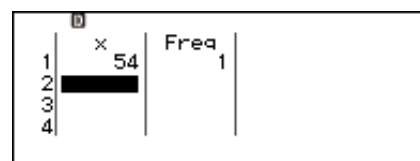
See Section 4.1 if you do not have a Freq(uecy) column.

You are now ready to enter the data.


 

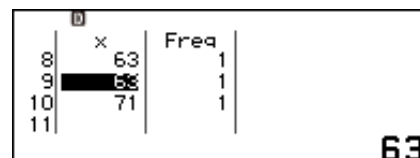



Pressing  ‘enters’ 54 with a frequency of 1 (in this case meaning it appears just once in our data).



Enter the rest of the data.

If you make an error, as I have with data point 9, simply *scroll* to it, type it again and press .



Alternatively, you can clear a row by selecting it and pressing .

A row can be inserted in the place of the row selected.

Select row 9 and then press:

- ⊙⊙ to select **Edit**
- ⊙Ⓚ to select **Insert Row**
- ⊙Ⓚ

	x	Freq
8	63	1
9	72	1
10	71	1
11		

72

	x	Freq
8	63	1
9	72	1
10	71	1
11		

0

Data can also be sorted in ascending or descending order, by the variable or frequency column.

Press:

- ⊙⊙
- ⊙Ⓚ ⊙Ⓚ to select **Sort**
- ⊙Ⓚ to select **x Ascending**
- ⊙Ⓚ

	x	Freq
1	45	1
2	52	1
3	54	1
4		

0

The data will then be displayed in the method selected.

Note: Once the data has been sorted, it cannot be returned to the order in which it was entered.

To clear/delete all the data previously entered, press:

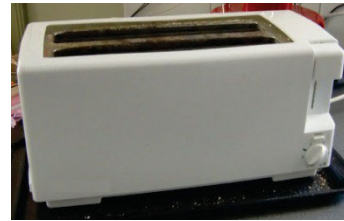
- ⊙⊙ to select **Edit**
- ⊙Ⓚ
- ⊙Ⓚ to select **Delete All**
- ⊙Ⓚ

	x	Freq
1		
2		
3		
4		

4.3 Five number summary

Before doing this section, be sure you have carried out the directions in the two previous sections.

I set my toaster to the ‘number 1’ setting and then measured how long it took to *pop*. I did this 16 times, letting it cool down in between measurements. The measurements (in seconds) are given below.



94, 96, 96, 96, 98, 98, 99, 99, 96, 97, 127, 96, 99, 96, 99, 96.


Find the five number summary for these data (minimum value, 1st quartile, median, 3rd quartile and maximum value).

From the  screen, launch the



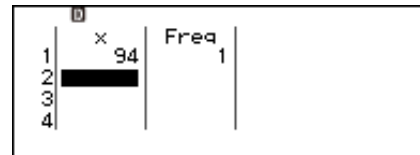
For this example, we have a *single* variable, time, so select **1-Variable**



 to open the data list.

You are now ready to enter the data.

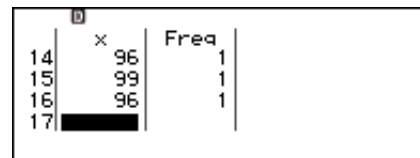
 







...

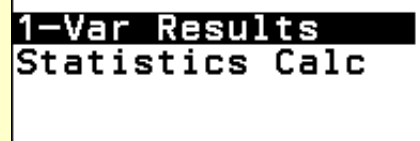
Enter all 16 data points.

Note: I am choosing to enter every data point as an individual and so the frequency of each will be one, even though some values (like 96) occur seven times.



Check all the data is correct by scrolling up and down (, ). Edit if required.

Press  when data entry is complete.



To display the summary statistics,
 select **1-Var Results** and then press
 (OK).

```

  D
  x̄      =98.875
  Σx     =1582
  Σx2   =157298
  σ2x    =54.859375
  σx     =7.406711484
  s2x    =58.51666667
  
```

The results for the five number summary
 (min(x), Q1, Med, Q3, max(x)) will appear over
 three screens.

```

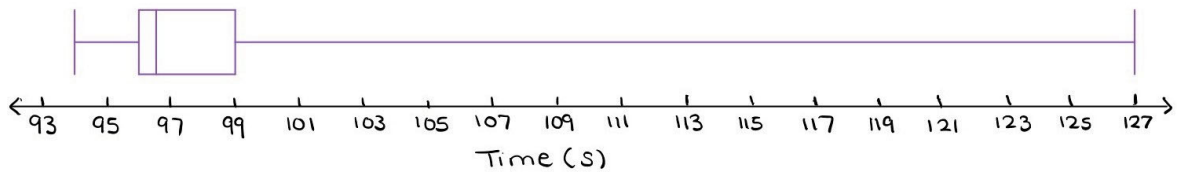
  D
  sx     =7.649618727
  n      =16
  min(x) =94
  Q1     =96
  Med    =96.5
  Q3     =99
  
```

Use the (↑), (↓) to toggle between them.

```

  D
  max(x) =127
  
```

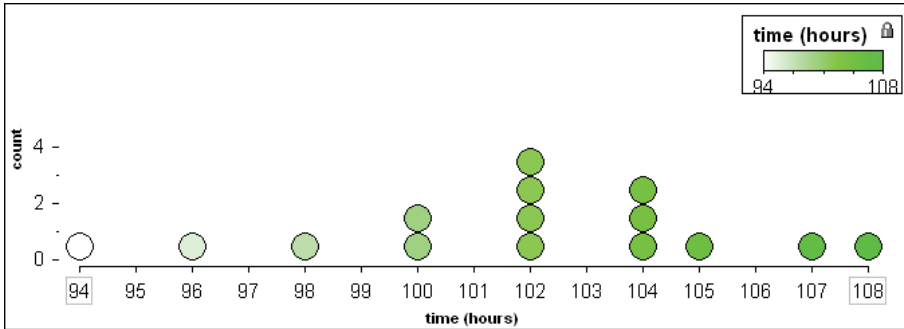
From these statistics a boxplot can be drawn, by hand.



4.4 Mean and standard deviation

Before doing this section, be sure you have carried out the direction in sections 4.1 and 4.2.

A candle shop makes a certain type of candle called *large-scented*. Each candle is to have a label displaying how long the candle is expected to burn. To determine the expected time, a sample of 15 candles are burned and the number of hours that each burned for (rounded to the nearest hour) is recorded. The data is given below in the form of a dot plot.



Calculate the sample mean (\bar{x}) and the sample standard deviation (s).

From the screen, launch the



1-Variable
2-Variable

For this example, we have a *single* variable, time, so select **1-Variable** and then press

to open the data lists.

	x	Freq
1		
2		
3		
4		

You are now ready to enter the data.

...

	x	Freq
1	94	1
2		
3		
4		

Enter all nine scores from the dotplot and change the frequency value as required.

For example, we have two scores of 100 and so after entering 100 press:

.

	x	Freq
2	96	1
3	98	1
4	100	2
5		

Check all the data is correct by scrolling up and down (⬆, ⬇). Edit if required.

	x	Freq
7	105	1
8	107	1
9	108	1
10		

Press **OK** when data entry is complete.

1-Var Results
Statistics Calc

To display the summary statistics,
select **1-Var Results** and then press **OK**.

\bar{x}	=101.8666667
Σx	=1528
Σx^2	=155858
$\sigma^2 x$	=13.71555556
σx	=3.703451843
$s^2 x$	=14.6952381

The results for the mean (\bar{x}) and standard deviation (s_x) will appear over two screens.

Use the ⬆ and ⬇ to toggle between them.

s_x	=3.833436852
n	=15
min(x)	=94
Q1	=100
Med	=102
Q3	=104

4.5 Linear Regression


In 1948 General Motors Holden (GMH) made the first Holden, while continuing to also assemble other makes of cars. From this time onwards, GMH decreased the assembly of non-Holden cars, as the production of Holden cars increased.



The table below shows the number of non-Holden cars (N thousands) assembled in each year from 1948 to 1959. In the table, year 1 represents 1948.

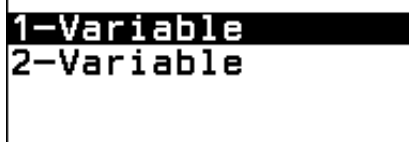
Year	1	2	3	4	5	6	7	8	9	10	11	12
N	25.2	22.2	23.9	20.3	15.4	14.4	19.3	20.6	15.1	10.9	13.8	13.2

- Find the slope of the least squares regression line.
- Use the equation to predict how many non-Holden cars would have been made, if the trend seen above continued, in 1974.



From the  screen, launch the



application.



Press:

-  to select **2-Variable**,
-  to open the data lists.

	x	y	Freq
1			
2			
3			
4			

Note 1:

You may be asked if you wish to clear data. This will happen if you have data in the 1-Variable section.

You must choose **Yes** if you want to proceed.

Note 2:

If data already exists in the lists, delete it – see section 4.2.

Note 3:

See section 4.1 if your calculator does not have a Freq(uency) column displayed.

Enter the data.

	x	y	Freq
10	10	10.9	1
11	11	13.8	1
12	12	13.2	1
13			

Once entered and checked, press **OK**.

```
2-Var Results
Reg Results ▶
Statistics Calc ▶
```

To find the slope and y-intercept of the least squares regression line, press:

- ▼** to select **Reg Results** ▶,
- OK** **▼** to select **y=a+bx** ▶,
- OK**.

```
y=a+bx
a=24.76969697
b=-1.063286713
r=-0.825915913
```

Therefore, the equation of the least squares line is $N \approx -1.06 \times year + 24.77$

To prepare to do a statistical calculation using the slope and y-intercept, press:

- ↶** to return to the data lists,
- OK** **▼** **▼** to select **Statistics Calc** ▶,
- OK** to select **y=a+bx** ▶,
- OK** to open the statistics calculation screen.

```
Statistics
y=a+bx
```

To calculate the predicted number of non-holdens made in 1974, the values of a and b can be found in the CATALOG.

Press:

- to select **Statistics** ▶,
- OK** **▼** **▼** **▼** to select **Regression** ▶,
- OK** to access a and b.

```
a      b
r      x̄
y
```

Enter $a + 27 \times b$ and press **OK**.

Note: To enter b, repeat the steps above.



```
a+27b      -3.939044289
```

Alternatively, the \hat{y} shortcut can be used.

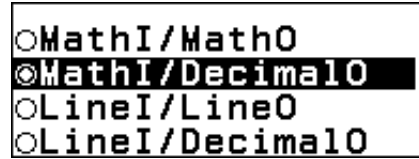
Oh, a negative number of cars.
I guess the trend did not continue!

```
27ŷ      -3.939044289
```










4.6 Random numbers

From the  screen, launch the  application.


Check that your calculator is set to MathI/DecimalO. See section 2.1.



Press:










  to select **Probability** 
   to select **Random Number** 
 

This function produces pseudo-random numbers between 0 and 1 (with three decimal places).


Press  a few more times to see more of them.



  to select **Probability** 
   to select **Random Number** 
 














Pseudo-random numbers between 0 and 1000 are produced.

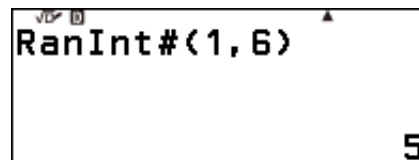
Press  a few more times to see more of them.




To produce pseudo-random numbers between 1 and 6 inclusive.

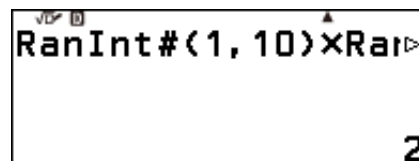
Press:

  to select **Probability** 
  to select **Random Integer**
 
  – to enter (,) 
 




On the screen right, I am calculating the *product* of two pseudo-random numbers between 1 and 10 inclusive.

If we keep pressing  continually, will square numbers be common or uncommon? Why?



fx-8200 AU at a glance

Here is a refresher of the key functions of the fx-8200 AU.



5.1 Degrees, minutes and seconds

Set your calculator to MathI/MathO. See section 2.1.

One revolution can be broken up into 360 equal turns, each called 1 degree (1°).

What does a 90° angle look like?

What does a 1° angle look like?

What if it is less than 1° ?

One degree can be broken up into 60 equal turns (small ones), each called 1 minute ($1'$).

One minute can be broken up into 60 equal turns (very small ones), each called 1 second ($1''$).

So, 42.5° would be the same as $42^\circ 30' 0''$ and 42.125° ($42\frac{1}{8}^\circ$) would be the same as $42^\circ 7' 30''$ (as $60 \div 8 = 7.5$) – phew!


Convert each of the following into degrees, minutes and seconds.

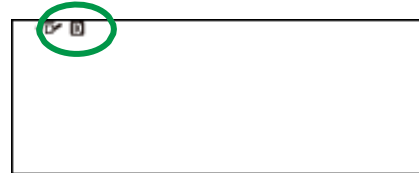
a) 36.5°








b) 36.6°

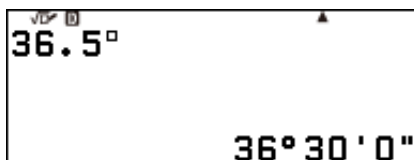
c) 36.25°








From the  screen, launch the  application.

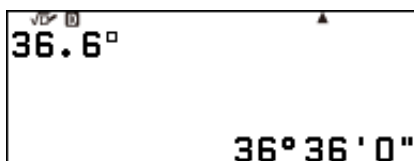
Before starting we need to be sure that the calculator is set to work in degrees. If you can see a small  at top of screen, then it is. If not, do the following:









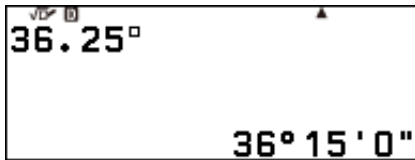
-  to select **Calc Settings** 
-   to select **Angle Unit** 
-  to see the options,
-  to choose the angle setting to be Degree.



-    
-  then  (to enter (0.))
- 



-    
-  then  (0.))
- 

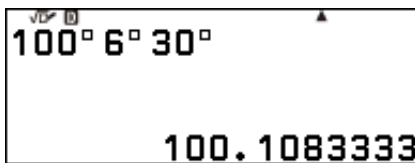


3 6 . 2 5
 ↑ then + (°'")
 EXE

Consider the reverse process, converting an angle represented in degrees, minutes and seconds to decimal form (or even fractional form).

What would $100^\circ 6' 30''$ be in decimal form?

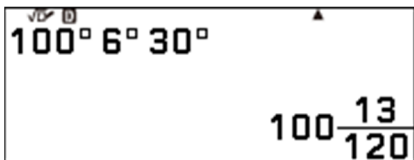
Convert each of the following decimal form.
 a) $100^\circ 6' 30''$ b) $34^\circ 20' 20''$ c) $51^\circ 28' 38''$



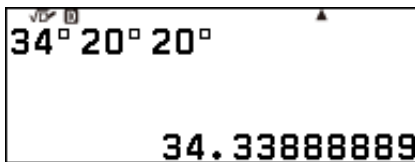
1 0 0
 ↑ then + (°'")
 6
 ↑ then + (°'")
 3 0
 ↑ then + (°'")
 ↑ then EXE (≈)



To see the fractional form press:
 FORMAT ↓ ↓ ↓ to select **Improper Fraction**
 OK

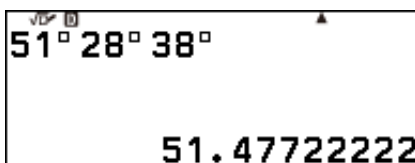


To see the mixed number press:
 FORMAT ↓ ↓ ↓ ↓ to select **Mixed Fraction**
 OK



3 4 ↑ + (°'")
 2 0 ↑ + (°'")
 2 0 ↑ + (°'")
 ↑ then EXE (≈)

Did you predict that? It is $34 + \frac{20}{60} + \frac{20}{3600}$. Check it.

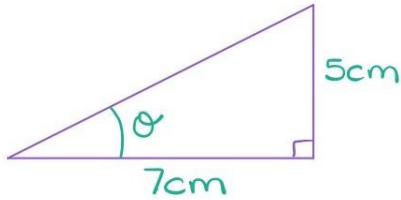


The angle given in part c) is the longitude measure of Greenwich. Why is Greenwich important?

5.2 Trigonometric calculations

Set your calculator to MathI/MathO. See section 2.1.

Suppose you are required to find the size of the angles (expressed in degrees minutes and seconds) in a right-angled triangle with perpendicular legs of length 5 cm and 7 cm. We could begin as follows:

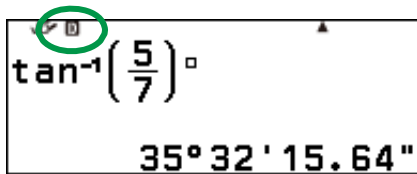


$$\tan(\theta) = \frac{5}{7}$$

$$\theta = \tan^{-1}\left(\frac{5}{7}\right)$$

$$\theta = \dots$$

To calculate the value of θ :



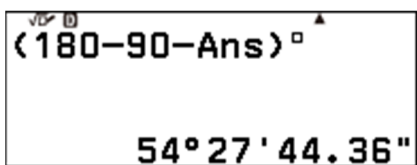
First ensure the calculator is set in **D**egrees.

If it is not, then:

- $\left[\equiv\right]$ to select **Calc Settings** \blacktriangleright ,
- $\left[\text{OK}\right]$ $\left[\vee\right]$ to select **Angle Unit** \blacktriangleright ,
- $\left[\text{OK}\right]$ to see the options,
- $\left[\text{OK}\right]$ to choose the angle setting to be Degree.
- $\left[\text{AC}\right]$

Then:

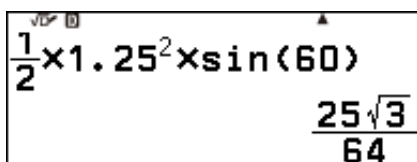
- $\left[\uparrow\right]$ $\left[\tan\right]$ (to enter (\tan^{-1}))
- $\left[5\right]$ $\left[\frac{\square}{\square}\right]$ $\left[7\right]$ $\left[>\right]$ $\left[)\right]$
- $\left[\uparrow\right]$ then $\left[+\right]$ (to enter $(\circ, ' , '')$)
- $\left[\text{EXE}\right]$



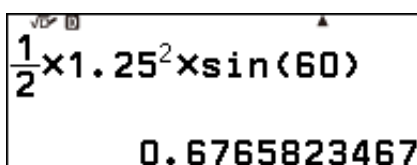
To calculate the other unknown angle:

- $\left[(\right]$ $\left[1\right]$ $\left[8\right]$ $\left[0\right]$ $\left[-\right]$ $\left[9\right]$ $\left[0\right]$ $\left[-\right]$ $\left[\text{Ans}\right]$ $\left[)\right]$
- $\left[\uparrow\right]$ then $\left[+\right]$ (to enter $(\circ, ' , '')$)
- $\left[\text{EXE}\right]$

What is the area of an equilateral triangle with side length 1.25 cm?



- $\left[1\right]$ $\left[\frac{\square}{\square}\right]$ $\left[2\right]$ $\left[>\right]$
- $\left[\times\right]$ $\left[1\right]$ $\left[.\right]$ $\left[2\right]$ $\left[5\right]$ $\left[\square^2\right]$
- $\left[\times\right]$ $\left[\sin\right]$ $\left[6\right]$ $\left[0\right]$ $\left[)\right]$
- $\left[\text{EXE}\right]$



To see the decimal approximation for $\frac{25\sqrt{3}}{64}$ cm², press $\left[\uparrow\right]$ then $\left[\text{EXE}\right]$ (\approx) .

Solve the equation $\sin(3x) = \frac{\sqrt{3}}{2}$ for $0^c < x < \pi^c$

First ensure the calculator is set in **Radians**.
If it is not, then:

- to select **Calc Settings**
- to select **Angle Unit**
- to see the options,
- to choose the angle setting to be Radian.
-

Then:

- (to enter (\sin^{-1}))
-
-

So,

$$3x = \frac{\pi}{3} \pm 2k\pi \text{ or } 3x = \frac{2\pi}{3} \pm 2k\pi$$

Therefore,

$$x = \frac{\pi}{9} \pm \frac{2k\pi}{3} \text{ or } x = \frac{2\pi}{9} \pm \frac{2k\pi}{3}$$

To find more solutions, we can add or subtract multiples of $\frac{2\pi}{3}$.

- (to enter (π))
- (to enter (π))
-

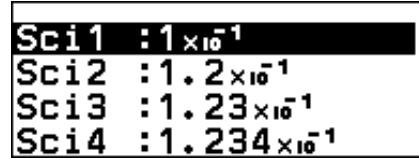
Convince yourself that $\sin(3x) = \frac{\sqrt{3}}{2}$ for $0^c < x < \pi^c$, has four solutions.

5.3 Scientific notation and ENG notation

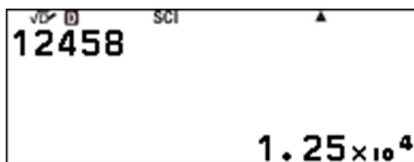
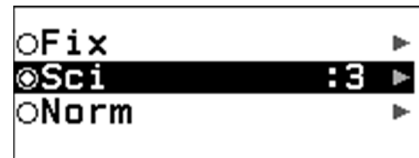
Numbers can be expressed in scientific notation, correct to 3 significant figures, by setting the calculator to display values in that way.

Press:

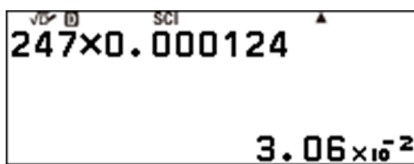
- to select **Calc Settings** ▶,
- to select **Number Format** ▶,
- to select **Sci** ▶,
- to see the options.



- to choose three significant figures.
- to return to the calculation screen.

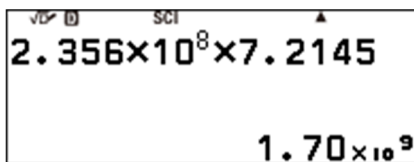


-
-



Enter this example.

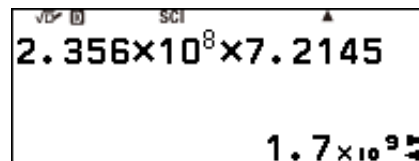
-
-



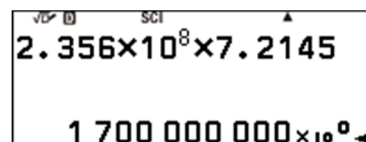
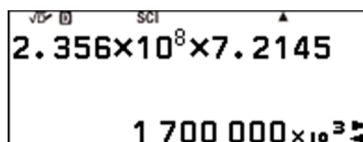
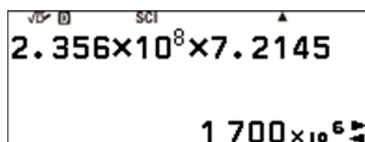
-
-
-
-

With the previous calculation active, press

- to select **ENG Notation**,
- to return to the calculation screen.



Press multiple times.



What does it do?

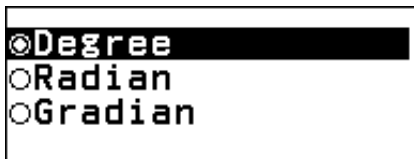
Press to go backwards.

Press to cancel ENG notation mode.

Now set your calculator back to Norm 2.

5.4 Radians to degrees

To convert an angle in radians to degrees, set the calculator to compute in degrees.

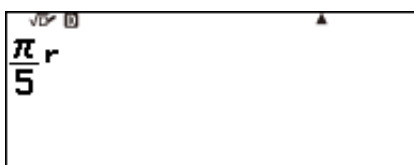


- to select **Calc Settings** ▶
- to select **Angle Unit** ▶,
- to see the options,
- to choose the angle setting to be Degree.
- to return to the calculation screen.

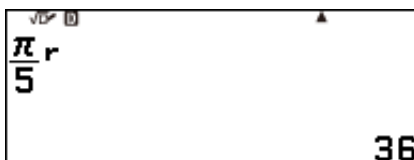
Convert $\frac{\pi^c}{5}$ to degrees.



- (π)
-
-

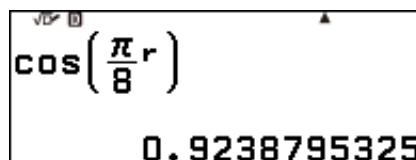


- to select **Angle/Coord/Sexa** ▶,
- to select **Radians**,
- to insert the radian symbol (r).



- to see the angle in degrees.

The **Angle/Coord/Sexa** ▶ menu options can be useful when used in an input, as they over-ride the angle unit setting of the calculator. For example, suppose we want to calculate $\cos\left(\frac{\pi^c}{8}\right)$. We can do this without having to change the calculator's angle setting to radians by ensuring the 'r' is added to the end of the input as shown below.



Note: Both c and r can be used to denote radians, as can rad.

6.1 Lowest common multiple (LCM)

Both the hot water tap and cold water tap in my sink are leaking; drip, drip, drip, drip, drip, drip, drip, ... and so on.

Every now and again I hear what sounds like a single big DRIP.

I figured out that the hot water tap drips every 8 seconds and the cold water every 14 seconds. How often do I hear the single big drip (i.e., when are they in sync)?

We could make two lists:

hot: 8, 16, 24, 32, 40, 48, 56, ...

cold: 14, 28, 42, 56, 70, ...

So, if the taps started dripping in unison I would hear the single big drip after 56 seconds and every 56 seconds after that, with 9 drips in between DRIPs.

56 is called the lowest common multiple (LCM) of 8 and 14.

The calculator is able to calculate the LCM of two integers.

Find the LCM of 8 and 14.

The image shows a calculator screen with the text "LCM(8, 14)" and the result "56". To the right of the screen are several circular icons representing calculator functions: a menu icon, a down arrow, a left arrow, an "OK" button, a right arrow, another "OK" button, the number "8", an up arrow, a right parenthesis ")", a comma "(", the number "1", the number "4", a right parenthesis ")", and an "EXE" button. To the right of these icons is a text instruction: "to select Numeric Calc" with a right arrow pointing to a black box containing "Numeric Calc", and "to select LCM" with a right arrow pointing to a black box containing "LCM".

The calculator agrees with my table!

Find the LCM of 8 and 15.

The image shows a calculator screen with the text "LCM(8, 15)" and the result "120". To the right of the screen are several circular icons representing calculator functions: a left arrow, another left arrow, a clear "X" button, the number "5", and an "EXE" button.

Note that $8 \times 15 = 120$. However $8 \times 14 \neq 56$. Try to explain this observation.

What must be true for the LCM of two integers, a and b , to be equal to the product ab ?

Things I learnt about my fx-8200 AU ...

A large grid of graph paper, consisting of 20 columns and 30 rows of small squares, intended for taking notes.

6.2 Greatest common divisor (GCD)

Consider the numbers 20 and 36.

20 can be found in the 1-times table, 2-times table, 4-times table, 5-times table, 10-times table and of course the 20-times table. Another way of saying this is that 20 is divisible by 1, 20 is divisible by 2, ...

Divisible means divides with no remainder.

36 is divisible by 1, 2, 3, ...

What is the largest number that will divide into, with no remainder, 20 and 36? This number is called the *greatest common divisor*, or GCD, of 20 and 36.

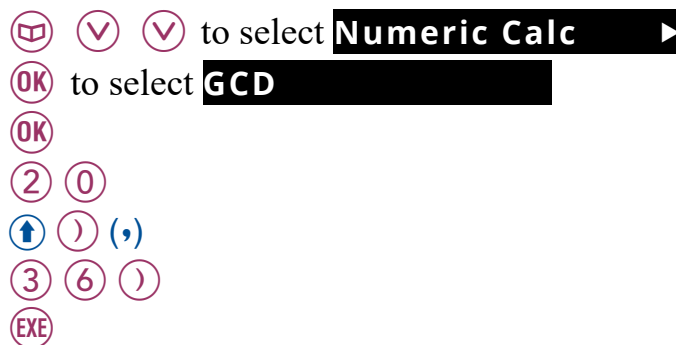
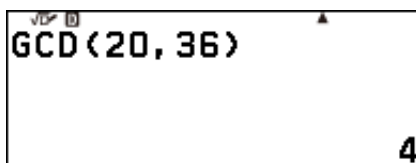
We can make two lists and compare:

20 is divisible by 1, 2, 4, 5, 10 and 20.

36 is divisible by 1, 2, 3, 4, 6, 9, 12, 18 and 36.

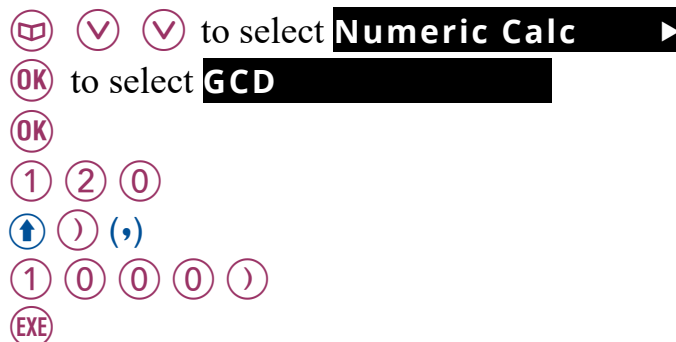
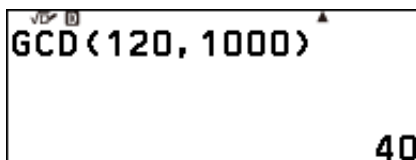
So 4 is the GCD of 20 and 36. Does the calculator agree?

Find the GCD of 20 and 36.



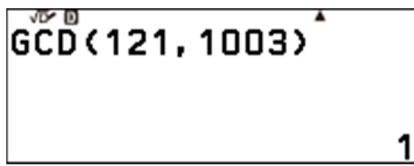
We have agreement!

Suppose we have a single rectangular block of land 120 m wide and 1000 m long and we want to divide it into identical square blocks. If the squares have integer dimensions, what is the size of the largest squares that can be used?



So a square 40 m by 40 m is the largest that can be used.

What is the GCD of 121 and 1003?



Edit the previous calculation as follows:



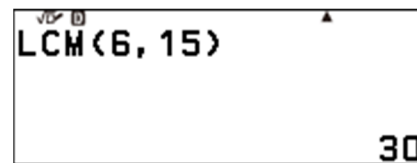
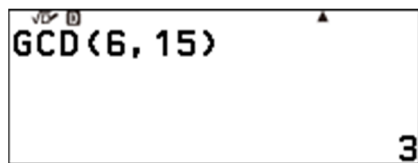
1!

So, there is no integer apart from 1 that will divide, with no remainder, 121 and 1003.

Such pairs of numbers are called co-prime, or relatively prime.

Does that mean 1003 is prime? 121 is clearly not as $11 \times 11 = 121$.

Find the product of the GCD and LCM of 6 and 15.



So $\text{GCD}(6, 15) \times \text{LCM}(6, 15) = 90$.

Note also that $6 \times 15 = 90$.

Coincidence? Try some more cases.

If you cannot find a counter example, try to reason why:

$$\text{GCD}(a, b) \times \text{LCM}(a, b) = ab, \text{ where } a, b \in \mathbb{Z}.$$

6.3 Prime factorisation

Is 1003 prime?

To find out we could start checking to see if the integers between 1 and $\sqrt{1003}$ divide 1003 with no remainder.

Clearly we can ignore all the even numbers, and since the digit sum is 4 then 3 will not work, nor 5, how about 7, ...

The calculator is able to very efficiently perform a process similar to that started above and return the number written as a product of its prime factors.

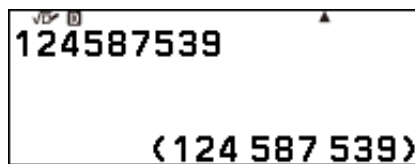
Prime factorise 1003.



So 1003 is not prime, it is divisible by 17 and 59 (as well as 1 and 1003).

Try and find the biggest prime you can in 60 seconds.

See if you can find one bigger than me:



36 has 9 divisors (or factors): 1, 2, 3, 4, 6, 9, 12, 18 and 36.

How can you determine this fact from its prime factorisation?

Below you can see the prime factorisation of 36 – I will leave it to you to think about. Try some other examples.



6.4 Verifying equality

Verify mode allows you to check whether or not different numerical forms, or algebraic expressions, are equal.

It is a useful mode for testing out your knowledge of various mathematical ideas/processes.

One 'fraction' example is shown right.

$\frac{1}{3} = 0.333 = 33\frac{1}{3}\%$
False

To enable Verify mode, press:

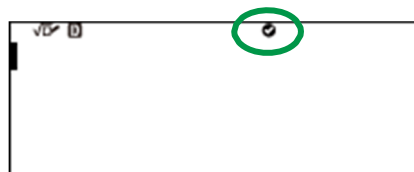
to select **Verify ON**,

to turn Verify on and return to the calculation screen.

You will notice the at the top of the screen.

This indicates that Verify is on.

When Verify is on, you cannot calculate in a typical manner, you are locked out of that.



The number $4\sqrt{5}$ can be written in many different forms.

What is $4\sqrt{5}$ when written in the form \sqrt{k} where k is a whole number?

I think it is $\sqrt{20}$; is that true? Let's verify.

$\sqrt{20} = 4\sqrt{5}$
False

False!

See if you can figure out the correct answer and get the calculator to return True. Try some more examples.

Can you write down the correct decimal form and percentage form of $\frac{1}{8}$?

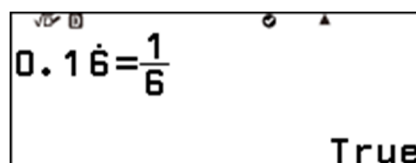
I think $\frac{1}{8} = 0.125 = 12.5\%$; is that true? Let's verify.

$\frac{1}{8} = 0.125 = 12.5\%$
True

Success!

Is $0.1\dot{6} = \frac{1}{6}$?

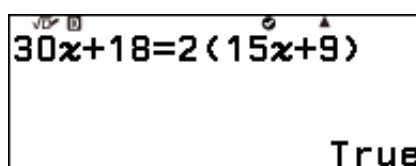
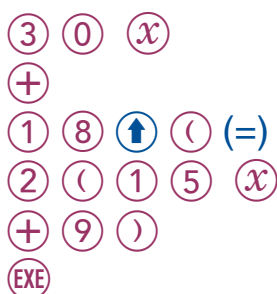
To enter a number in recurring decimal form, like $0.1\dot{6}$, and verify whether it is $\frac{1}{6}$, press:



Try some more fraction/decimal form/percentage form examples.

Can you write down a factorised form of $30x + 18$?
Check your answer using Verify mode.

I think that $30x + 18 = 2(15x + 9)$; is that true? Let's verify.



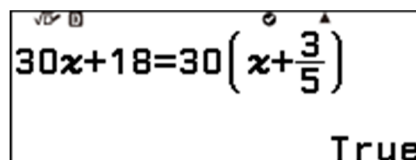
Success!

However, now that I think about it a little more, I do not think $2(15x + 9)$ is *fully* factorised.

Try to find a different expression that is also a factored form of $30x + 18$, try for the *fully* factorised form.

There are many factorised forms of $30x + 18$, but only one that is *fully* factorised.

The one shown to the right is **not** considered *fully* factorised. 😊



When the calculator verifies the truth of an algebraic expression, it is only verifying it for one numerical value of x . The value of x in its memory.

To see that value, and change it, press the VARIABLE key, $\left(\frac{\square}{\square}\right)$.

It is wise to think carefully about the value(s) of x you choose to verify an algebraic equality, before concluding that the algebraic expressions are equal in general.

6.5 Summation

Set your calculator to MathI/MathO. See section 2.1.

The concept of summation is the adding up of a sequence of numbers, where the sequence obeys a rule.

Consider following:

- $\frac{1}{4}$
- $\frac{1}{4} + \left(\frac{1}{4} \times \frac{1}{4}\right)$
- $\frac{1}{4} + \left(\frac{1}{4} \times \frac{1}{4}\right) + \left(\frac{1}{4} \times \frac{1}{4} \times \frac{1}{4}\right)$

Each of these are consecutive steps in the sum of a sequence of numbers. At each step we add on one more number, and we keep doing this forever.

Given the rule is that the next number is *one-quarter of the previous*, then the never-ending summation, S_n , can be written as follows:

$$S_n = \frac{1}{4} + \left(\frac{1}{4} \times \frac{1}{4}\right) + \left(\frac{1}{4} \times \frac{1}{4} \times \frac{1}{4}\right) + \left(\frac{1}{4} \times \frac{1}{4} \times \frac{1}{4} \times \frac{1}{4}\right) + \dots + \frac{1}{4^n}$$

where n is a positive whole number.

The value of S_2 can be calculated as follows:



A calculator display showing the calculation of $\frac{1}{4} + \frac{1}{4^2}$. The display shows $\frac{1}{4} + \frac{1}{4^2}$ and the result $\frac{5}{16}$.



The decimal form can also be calculated.

↑ then EXE (≈)



A calculator display showing the calculation of $\frac{1}{4} + \frac{1}{4^2}$ resulting in the decimal value 0.3125.

Complete the following table for $1 \leq n \leq 6$.

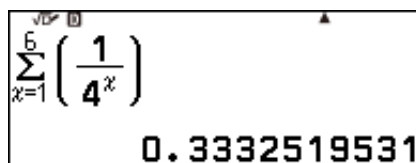
n	1	2	3	4	5	6
(S_n) (fractional form)	$\frac{1}{4}$	$\frac{5}{16}$				
S_n (decimal form)	0.25	0.3125				

What do you notice?

There is a more efficient way to calculate the value of a given number of steps of a summation using this calculator.

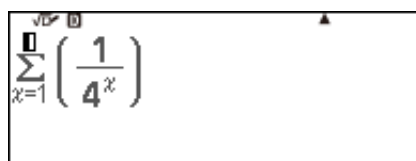
S_6 can be calculated as follows.

- Ⓜ to select **Func Analysis** ▶
- ⓄK to select **Summation(Σ)**
- ⓄK
- 1 $\frac{\square}{\square}$ 4 \square^{\square} ∞
- ∨ 1 \wedge 6
- ↑ then EXE (≈)



To calculate further steps in this summation press:

- ➤ ➤ to move the cursor to the right of the 6,
- ⓧ to delete the 6.



You can now enter any value of n you wish.

Calculate S_{10} , S_{12} , ...

Can you suggest what will happen to the value of the sum, S_n , as the value of n becomes larger and larger (I.e., as $n \rightarrow \infty$)?

Can you “fraction-up” the square shown below in a way that would convince another person that as $n \rightarrow \infty$, $S \rightarrow \frac{1}{3}$?



Calculate some steps in the sum:

$$S_{5,n} = \frac{1}{5} + \frac{1}{5 \times 5} + \frac{1}{5 \times 5 \times 5} + \dots + \frac{1}{5^n}$$

What happens to the value of $S_{5,n}$ as $n \rightarrow \infty$?

Calculate some steps in the sum:

$$S_{6,n} = \frac{1}{6} + \frac{1}{6 \times 6} + \frac{1}{6 \times 6 \times 6} + \dots + \frac{1}{6^n}$$

What happens to the value of $S_{6,n}$ as $n \rightarrow \infty$?

Calculate some steps in the sum:

$$S_{7,n} = \frac{1}{7} + \frac{1}{7 \times 7} + \frac{1}{7 \times 7 \times 7} + \dots + \frac{1}{7^n}$$

What happens to the value of $S_{7,n}$ as $n \rightarrow \infty$?

Consider the sum:

$$S_{a,n} = \frac{1}{a} + \frac{1}{a \times a} + \frac{1}{a \times a \times a} + \dots + \frac{1}{a^n}$$

Can you suggest what happens to the value of $S_{a,n}$ as $n \rightarrow \infty$?

Can you prove that your suggestion is correct?

To finish of this section, consider the sum:

$$S_n = 1 + \frac{2}{3} + \frac{4}{9} + \frac{8}{27} + \dots + \frac{2^{n-1}}{3^{n-1}}$$

What happens to the value of S_n as $n \rightarrow \infty$?

Note:

Instead of summing a sequence of numbers, one can find their product.

For example,

$$P_n = \frac{7}{9} \times \frac{26}{28} \times \frac{63}{65} \times \frac{124}{126} \times \dots$$

The 'product' function (Π) can be used to investigation this critter. Investigate away.


Summation(Σ)
Product(Π)
Logarithm(logab)
Logarithm(log)

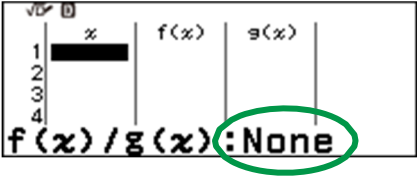
7.1 Making a table of values for a function

Consider the function:

$$f(x) = \frac{2x - 1}{x}$$

Make a table of values of $f(x)$ for $-10 \leq x \leq 10$ and see what you notice.

From the  screen, launch the  application.













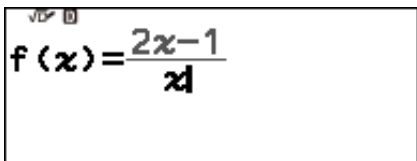
x	f(x)	g(x)
1		
2		
3		
4		

f(x)/g(x):None


None tells us that there are no functions defined in the calculator.

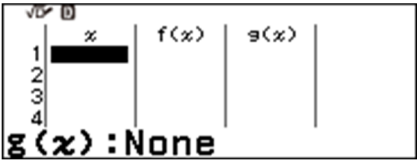
To define $f(x)$ in the calculator press:

-  (TOOLS),
-  to select **Define f(x)/g(x)**,
-  to select **Define f(x)**,
-        to enter the function.



$$f(x) = \frac{2x-1}{x}$$

 to return to the table.



x	f(x)	g(x)
1		
2		
3		
4		

g(x):None

-  (TOOLS) to select **Table Range**,
-  to see the Table Range settings.

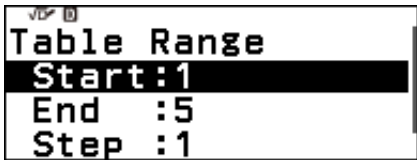


Table Range	
Start:	1
End:	5
Step:	1

-    
-   

You are now prepared to calculate values for $f(x)$ and $g(x)$ for all integer values (Step = 1) in the interval, $-10 \leq x \leq 10$.

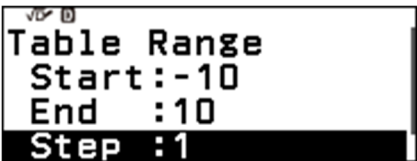


Table Range	
Start:	-10
End:	10
Step:	1

 to select Execute.

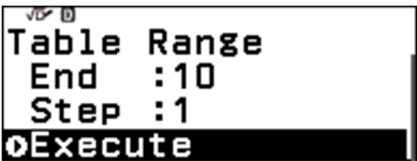


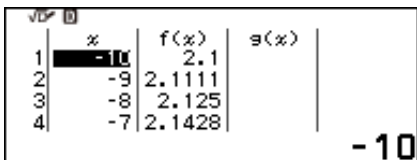


Table Range	
End:	10
Step:	1
 Execute	

 to see the table.



x	f(x)	g(x)
-10	2.1	
-9	2.1111	
-8	2.125	
-7	2.1428	

- 10

You can scroll up and down the table using \downarrow and \uparrow .

x	$f(x)$	$g(x)$
-10	2.1	
-9	2.1111	
-8	2.125	
-7	2.1428	

x	$f(x)$	$g(x)$
-2	2.5	
-1	3	
0	ERROR	
1	1	

x	$f(x)$	$g(x)$
7	1.8571	
8	1.875	
9	1.8888	
10	1.9	

Notice that when $x = 0$, $f(x) = \text{ERROR}$.

Can you explain why ERROR is returned?

Also notice that at either ends of the table, $f(x)$ gets close to 2.

Is there an x value for which $f(x) = 2$?

Change the table range to $-20 \leq x \leq 10$ and look at the values of $f(x)$.

Now change the table range to $10 \leq x \leq 20$ and look at the values of $f(x)$.

Did you find an x value for which $f(x) = 2$?

Mmm. 🤔

7.2 Solving an equation using table of values


Consider the functions:



$$f(x) = x^2 + 2x + 7 \text{ and } g(x) = 6x + 3.$$

Are there any values of x that return the same value of $f(x)$ and $g(x)$?










I.e., are there any values of x for which $f(x) = g(x)$?

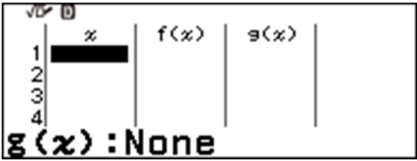
One way to find an answer to this question is to make a table of values for each function and compare.

The  application enables us to do just that.

From the  screen, launch the  application.

If the table on your calculator contains numbers press:




















-  (TOOLS),
-    to select **Edit** 
-   to select **Delete All** 
-  to clear the table of numbers.

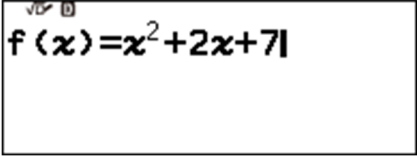


x	f(x)	g(x)
1		
2		
3		
4		


g(x) : None

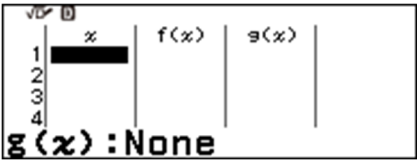
To define $f(x)$ in the calculator press:

-  (TOOLS),
-  to select **Define f(x)/g(x)** 
-  to select **Define f(x)** 
-        (if you completed 7.1),
-        to enter the function.



f(x) = x² + 2x + 7












-  to return to the table.

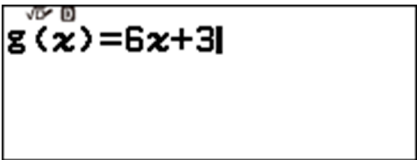


x	f(x)	g(x)
1		
2		
3		
4		


g(x) : None

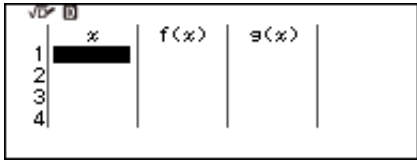
To define $g(x)$ press:

-  (TOOLS),
-  to select **Define f(x)/g(x)** 
-   to select **Define g(x)** 
-      to enter the function.



g(x) = 6x + 3

-  to return to the table.



x	f(x)	g(x)
1		
2		
3		
4		

g(x) : None

5 **EXE** will calculate $f(5)$ and $g(5)$.

Clearly $x = 5$ is not a value that makes $f(x) = g(x)$ true. 😞

x	$f(x)$	$g(x)$
5	42	33

Instead of entering one value of x at a time, we can calculate the values of $f(x)$ and $g(x)$ for a set of x values.

000 (TOOLS) to select **Table Range**,
OK to see the Table Range settings.

Table Range		
Start	:	1
End	:	5
Step	:	1

- **1** **0** **EXE** **1** **0** **EXE**
 You are now prepared to calculate values for $f(x)$ and $g(x)$ for all integer values (Step = 1) in the interval, $-10 \leq x \leq 10$.

Table Range		
Start	:	-10
End	:	10
Step	:	1

✓ to select Execute.

Table Range		
End	:	10
Step	:	1
Execute		

EXE to see the table.

x	$f(x)$	$g(x)$
-10	87	-57
-9	70	-51
-8	55	-45
-7	42	-39

You can scroll up and down the table using **✓** and **^**.

x	$f(x)$	$g(x)$
0	7	3
1	10	9
2	15	15
3	22	21

Note:

You can scroll across the table using **<** and **>**.

So, $x = 2$ makes $f(x) = g(x) = 15$. 😊

Do you think there might be any other values of x for which $f(x) = g(x)$?

You could change the Table Range and explore further, but we could never look at all values of x .

Using an algebraic approach to solve the equation $x^2 + 2x + 7 = 6x + 3$ will give us all possible values of x for which $f(x) = g(x)$.

We will start:

$$\begin{aligned}
 x^2 + 2x + 7 &= 6x + 3 \\
 \Rightarrow x^2 - 4x + 4 &= 0 \\
 \Rightarrow \dots
 \end{aligned}$$

Can you finish it off?


7.3 Checking if two algebraic expressions are equal



The expressions $x^2 + 8$ and $\sqrt{x}+8$ are equal in value if $x = 0$.
 But if $x = 4$, then the expressions are not equal, since $24 \neq 10$.
 So, $x^2 + 8 \neq \sqrt{x}+8$ for all values of x .

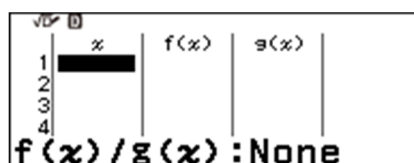
Ashley believes that when $2x^2 + 11x + 15$ is factorised, it is equal to $(2x + 5)(x + 3)$.

Use a table of values to check whether or not Ashley's belief is true for more than one value of x .



One way to begin answering this question is to make a table of values for each function and compare.

The  application enables us to do just that.

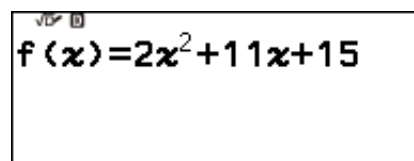
From the  screen, launch the  application.




To define $f(x)$ press:





-  (TOOLS),
-  to select **Define $f(x)/g(x)$** ,
-  to select **Define $f(x)$** ,

Enter $2x^2 + 11x + 15$.

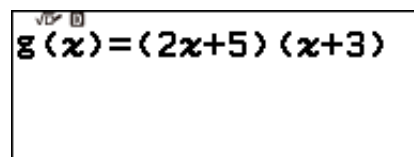












-  to return to the table.

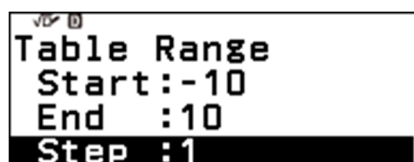
To define $g(x)$ press:

-  (TOOLS),
-  to select **Define $f(x)/g(x)$** ,
-   to select **Define $g(x)$** ,

Enter $(2x + 5)(x + 3)$.



-  to return to the table.
-  (TOOLS) to select **Table Range**,
-  to see the Table Range settings.
-       



You are now prepared to calculate values for $f(x)$ and $g(x)$ for all integer values (Step = 1) in the interval, $-10 \leq x \leq 10$.

⏏ to select Execute.

Table Range		
End	:	10
Step	:	1
Execute		

⏏ to see the table.

x	f(x)	g(x)
-10	105	105
-9	78	78
-8	55	55
-7	36	36

You can scroll up and down the table using ⏏ and ⏏.

x	f(x)	g(x)
-10	105	105
-9	78	78
-8	55	55
-7	36	36

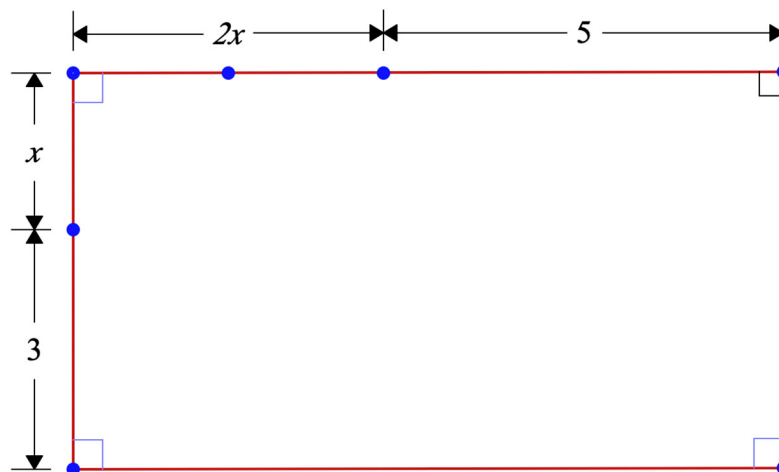
x	f(x)	g(x)
7	190	190
8	231	231
9	276	276
10	325	325

So, at least for the values of x in this table, $2x^2 + 11x + 15 = (2x + 5)(x + 3)$.

But is $2x^2 + 11x + 15 = (2x + 5)(x + 3)$ for all values of x ?

Use the rectangle below to convince yourself that

$$2x^2 + 11x + 15 = (2x + 5)(x + 3) \text{ for all } x.$$



8.1 Factorials

Ashley has four coloured balls and places them in a row as follows: red, yellow, green and blue.



Ashley wonders how many different ways these four balls can be ordered.

Ashley's teacher suggests a tree diagram might help. Ashley created the tree diagram you can see on the next page.

As you can see, the first stage of branches shows what is possible for the first position in the row. There are 4 options for the first position.

For each of these 4 options there are 3 options for the second position.

So, there are 4×3 , or 12, possible ways to fill the first two positions.

There are 2 branches leaving each one of the 12 second position branches.

So, there are 12×2 , or $4 \times 3 \times 2$, possible ways to fill the first three positions.

The last position can only be filled by the single remaining ball. Thus, there are $4 \times 3 \times 2 \times 1$ different orderings (often called arrangements) of the four balls.

There is a special way to represent products like $4 \times 3 \times 2 \times 1$, products of consecutive numbers all the way down to 1.

$$4 \times 3 \times 2 \times 1 = 4!$$

4! is pronounced *four factorial*.

$$10! = 10 \times 9 \times 8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1$$

$$n! = n \times (n - 1) \times (n - 2) \times \dots \times 3 \times 2 \times 1$$

To calculate $10!$, you can do the following.

Enter:

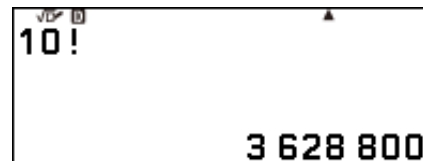
1 0

to select **Probability**

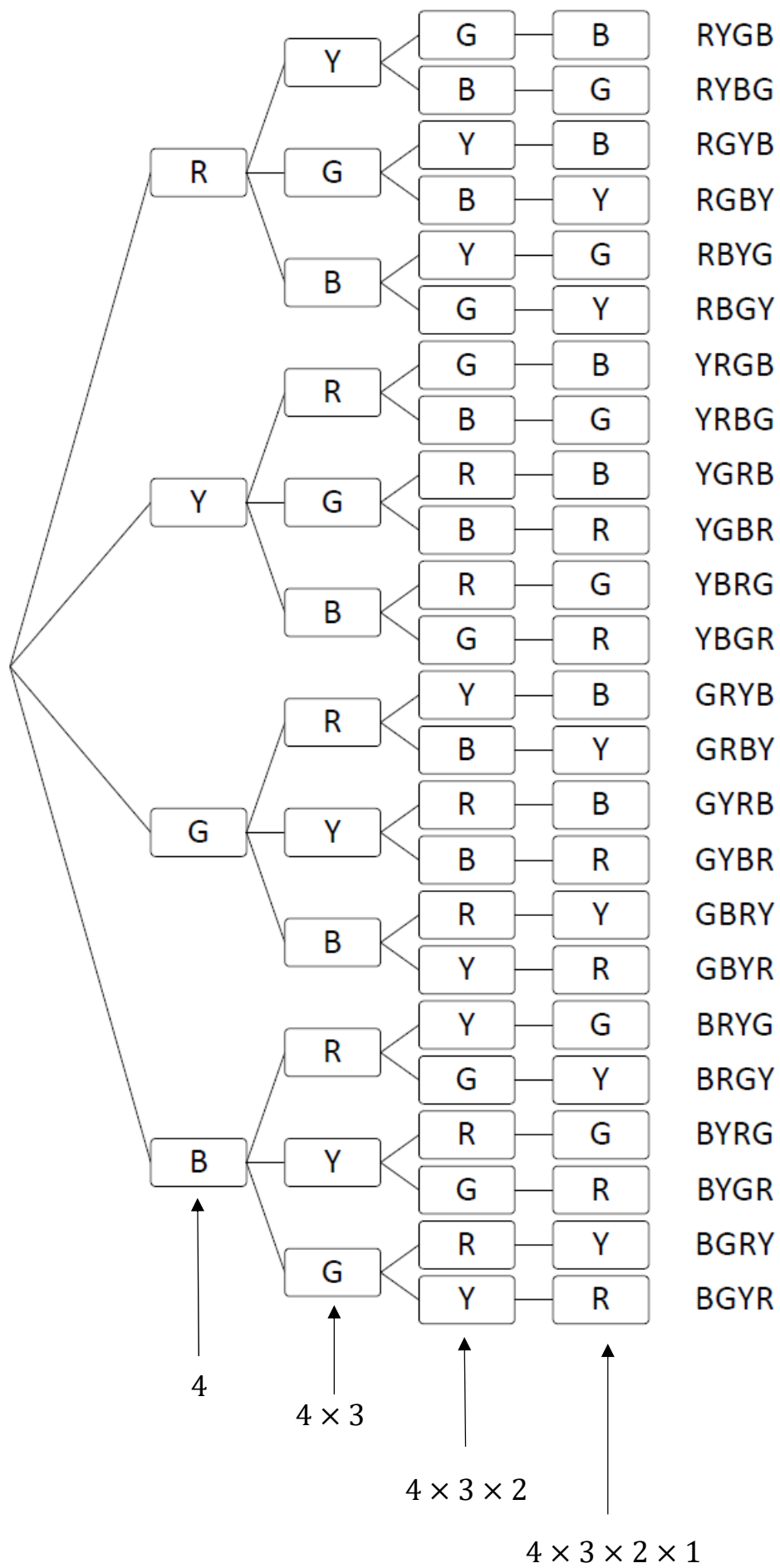
to select **Factorial(!)**

OK

EXE



So, $10! = 3\,628\,000$.



8.2 Permutations

Ashley was not done with the four balls, wondering how many different arrangements are possible if any 3 balls are chosen from the original set of four.

Ashley's teacher suggests that the tree diagram, as seen on the previous page, holds the answer.

Ashley realised that the branches in the first three stages of the tree diagram show all the possible arrangements.

So, there are $4 \times 3 \times 2$ arrangements.

What about if any two balls were chosen from the original 4?

We can use the branches in the first two stages; so, 4×3 arrangements.

What if Ashley had n balls and chose to arrange any r of them?

How many arrangements would be possible?

Well, all the stages in a tree diagram would provide $n!$ branches, but we would need to divide $n!$ that by $(n - r)!$

The formal name for arrangements of this type is *permutations*.

The notation for the number of permutations of r objects chosen from n objects is P_r^n , and

$$P_r^n = \frac{n!}{(n - r)!}$$

If Ashley had 15 differently coloured balls and took any 5 balls from the 15, how many permutations would there be?

$$P_5^{15} = \frac{15!}{(15 - 5)!}$$

To calculate P_5^{15} , you can do the following.

Enter:

1 5

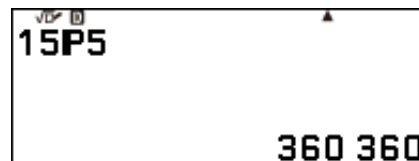
to select **Probability**

to select **Permutation(P)**

OK

5

EXE



So, $P_5^{15} = 360\,360$.

8.3 Combinations

Ashley was still not done, wondering what happened if only the colour combination deemed one collection to be different to another, rather than the colour *and* the order of the colours. How many of these type of collections would there be?

For example, instead of ordering the red, yellow and green balls as follows: R-Y-G, R-G-Y, Y-R-G, Y-G-R, G-R-Y and G-Y-R, we just paid attention to the combination of red, yellow and green and not the order.

Ashley thought for a while and realised there would be $\frac{1}{r!} \times P_r^n$ collections, because we only need to count $\frac{1}{r!}$ of the permutations.

Collections like this, when the order is not considered to matter, are formally called *combinations*.

The notation for the number of combinations of r objects chosen from n objects is C_r^n , and

$$C_r^n = \frac{1}{r!} \times P_r^n = \frac{n!}{(n-r)!r!}$$

If Ashley had 15 differently coloured balls and had to write down every combination of 5 balls taken from the 15, how many combinations would there be?

$$C_5^{15} = \frac{15!}{(15-5)!5!}$$

To calculate C_5^{15} , you can do the following.

Enter:

① ⑤

Ⓜ ⓪ to select **Probability** ▶

Ⓚ ⓪ ⓪ ⓪ to select **Combination(C)**

Ⓚ

⑤

Ⓚ



So, $C_5^{15} = 3\,003$.

8.4 Distribution – Normal

In 1861 Dr C.R.A. Wunderlich studied the body temperatures of many thousands of healthy people. The body temperatures were measured under standard conditions. Dr Wunderlich concluded that, for the population of healthy people, body temperature (T) was normally distributed with a mean of 37°C and a standard deviation of 0.5°C .

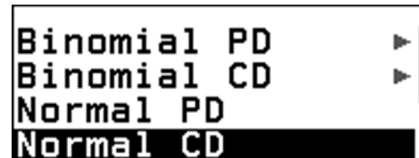
Using Dr Wunderlich's conclusions, find the percentage of the population of healthy people who had a body temperature:




- between 37°C and 38.2°C .
- above 39°C .

To answer part a) we need to calculate $P(37 < T < 38.2)$. We can calculate this as follows.

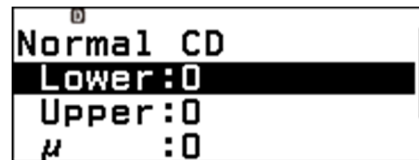
From the HOME () screen, launch the

Distribution application by selecting  and pressing .

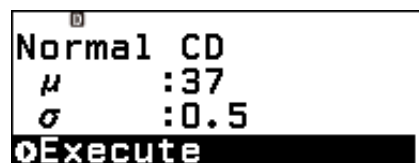


   to select Normal CD, which is the option we require.



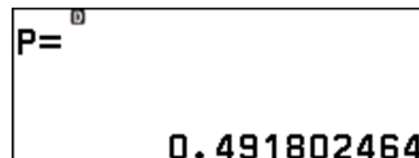




The parameters are now entered and you are ready to calculate $P(37 < T < 38.2)$.





So, about 49% of the population had a body temperature between 37°C and 38.2°C .

To answer part b) we need to calculate $P(T > 39)$.
We can calculate this as follows.

AC
3 9 EXE
1 0 0 0 EXE

```

Normal CD
Lower:39
Upper:1000
μ      :37
  
```

Note: When entering an upper limit in a situation like this, we enter a value that is many, many standard deviations higher than the mean. 1000 in this case.

∨ ∨ to select Execute.

```

Normal CD
μ      :37
σ      :0.5
Execute
  
```

EXE

```

P=
0.00003167126
  
```

So, about 0.003% of the population had a body temperature above 39°C.

Consider the *hottest* 10% of the population. What was the lowest body temperature in this group.

To answer this question we need to calculate t , such that $P(T \geq t) = 0.1$.

The Inverse Normal function can help us with this calculation. However, it calculates x , such that $P(X < x) = p$.

Thus to find the value of t we require, we need to find $P(T < t) = 0.9$. We can do that as follows:

↶ ↶
∨ ∨ ∨ ∨

Inverse Normal will then be selected, and it is the option we need.

```

Binomial CD
Normal PD
Normal CD
Inverse Normal
  
```

OK
0 . 9
EXE

```

Inverse Normal
Area :0.9
μ      :37
σ      :0.5
  
```

∨ ∨
EXE

```

xInv=
37.64077582
  
```

So, the lowest body temperature in the *hottest* 10% of the population was approximately 37.6°C.

8.5 Distribution – Binomial

A common drug is known to cause a mild side effect in some people. Data shows that one-in-eight of those who take the drug experience the side effect.

For a given group of people who take the drug, let Y be the number who experience the side effect.

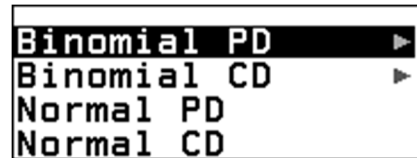
Given that Y can be modelled using the binomial distribution, find the probability that if:

- sixty-four people take the drug, eight will experience the side effect.
- 350 people take the drug, fifty or more will experience the side effect.

To answer part a) we note that $n = 64$, $p = \frac{1}{8}$ and we need to calculate $P(Y = 8)$. We can calculate this as follows.

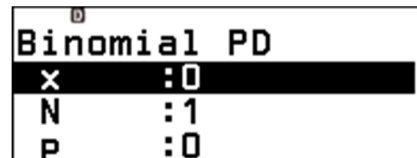
From the HOME () screen, launch the

Distribution application by selecting  and press  .

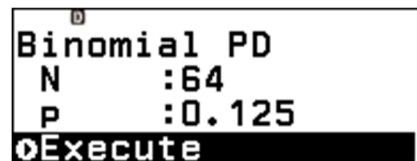


Binomial PD, which is the option we require.

  to select **Variable**

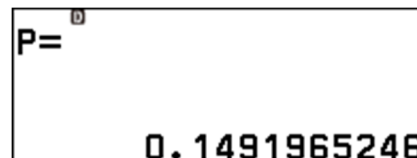





The parameters are now entered and you are ready to calculate $P(Y = 8)$.





So, there is about a 15% chance that eight of the sixty-four people will experience the side effect.

To answer part b) we note that $n = 350$ and we need to calculate $P(Y \geq 50)$.

We can calculate this with the help of the Binomial CD function. However, it calculates $P(Y \leq y)$. So, we need to calculate $1 - P(Y \leq 49)$, which we can do in the following way.

↶ ↷ ▼

Binomial CD will then be selected, and it is the option we need.

```
Binomial PD
Binomial CD
Normal PD
Normal CD
```

OK ▼ to select **Variable**
OK

```
Binomial CD
X :8
N :64
P :0.125
```

4 9 EXE
3 5 0 EXE
▼

The parameters are now entered and you are ready to calculate $P(Y \leq 49)$.

```
Binomial CD
N :350
P :0.125
Execute
```

EXE

So, $P(Y \leq 49)$ is approximately 82%.

```
P=
0.824465467
```

To store this value as A press:

↶ Ans
EXE

```
A=0.82446546 B=0
C=0 D=0
E=0 F=0
X=0 Y=0
Z=0
```

We can now calculate $1 - P(Y \leq 49)$ in the Calculation application as follows:

⏠ < < OK
1 - 4
EXE

```
1-A
0.175534533
```

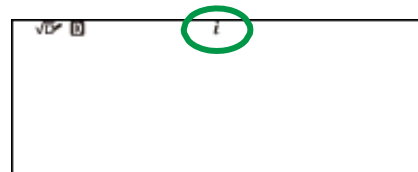
So, there is about a 17.6% chance that fifty or more people, of the 350, will experience the side effect.

9.1 Complex number calculations

The Complex application enables various calculations with complex numbers to be done.

From the  screen, launch the  application.




Note that i is seen at the top centre of the screen to indicate that outputs will be in cartesian form ($a + bi$). This is the default setting.

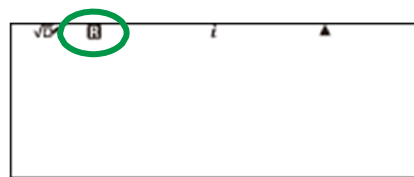


Results can be displayed in either cartesian ($a + bi$) or polar form ($r \angle \theta$).

First ensure the calculator is set to **R**adians.

If it is not, then:

-  to select **Calc Settings** ▶,
- OK**  to select **Angle Unit** ▶,
- OK** to see the options,
-  **OK** to choose the angle setting to be Radian.
- AC** to return to the calculation screen.








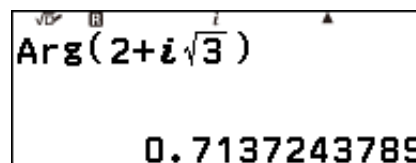
Note that **R** is seen on the top left of the screen to indicate the calculator will calculate set to work in radians.

Let $z = 2 + i\sqrt{3}$.

- a) Calculate $\arg(z)$
- b) Express z in polar form.

Press:

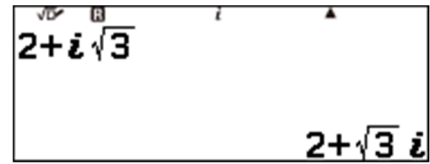
-  to select **Complex** ▶
- OK**   to select **Argument**
- OK**
- 2** **+**
-  **9** (i)
-  **3**
- >**
-)** **EXE**



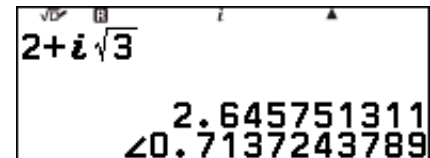
So, $\arg(z) \approx 0.714^c$.

To convert to polar form, we could now find the modulus, or use the automatic conversion feature as follows:

(2) (+)
 (↑) (9) (i)
 (√) (3)
 (>)
 (EXE)



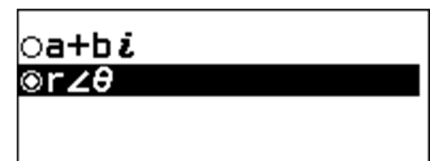
(FORMAT) (v) (v) (v) to select **Polar Coord**
 (EXE)



So, $2 + i\sqrt{3} \approx 2.65 \text{ cis}(0.714^c)$.

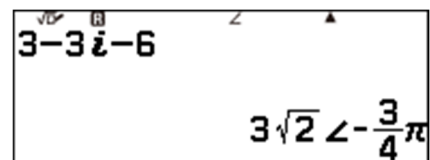
If you want the output of complex number calculations to be displayed in polar form without you having to convert them, you can change to Complex Result as follows:

(≡) to select **Calc Settings** ▶,
 (OK) (↑) (↑) (↑) to select **Complex Result** ▶,
 (OK) (v) to select **Or∠θ**,
 (OK) to choose the to be $r\angle\theta$.
 (AC) to return to the calculation screen.



Now enter:

(3) (-) (3)
 (↑) (9) (i)
 (-) (6)
 (EXE)





9.2 Vector calculations

When in the Vector application, various two and three-dimensional vector calculations can be done.

Given points P(1,2,3), Q(3,3,1) and R(8,4,11)

- Calculate $\overrightarrow{PQ} \cdot \overrightarrow{QR}$
- Calculate $\overrightarrow{PQ} \cdot \overrightarrow{PR}$
- Calculate a vector perpendicular to both \overrightarrow{PQ} and \overrightarrow{PR} .

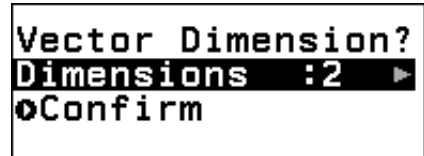
Firstly, $\overrightarrow{PQ} = (2,1,-2)$, $\overrightarrow{QR} = (5,1,10)$ and $\overrightarrow{PR} = (7,2,8)$.

From the  screen, launch the  application.



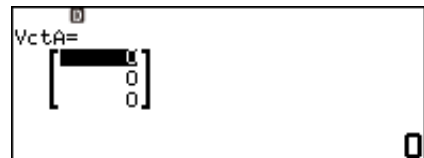
To set the dimension for each vector, press:


 to select **VctA:None**

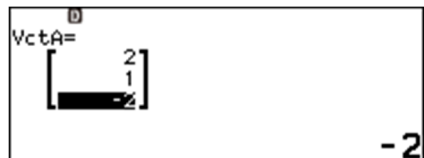



Press:

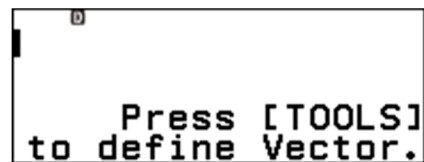
  select **3 Dimensions**
 to select **Confirm**

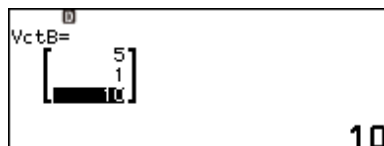
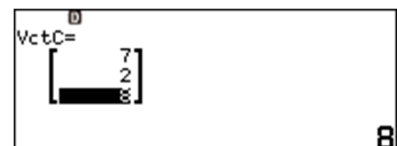
Enter each dimension, pressing  after each.



 to return to the vector calculation screen.



Repeat the process described above to enter \overrightarrow{QR} and \overrightarrow{PR} as VctB and VctC respectively.


Press  when you are done.

To calculate $\overrightarrow{PQ} \cdot \overrightarrow{QR}$ (the scalar (or dot) product), press:

2nd to select **Vector** \blacktriangleright

OK V to select **VctA**

OK



VctA

Then:

2nd to select **Vector** \blacktriangleright

OK to select **Vector Calc** \blacktriangleright

OK to select **Dot Product**

OK



VctA · I

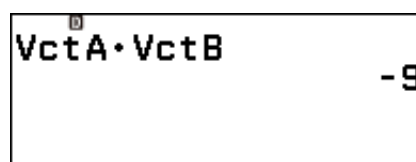
Then:

2nd to select **Vector** \blacktriangleright

OK V V to select **VctB**

OK

OK

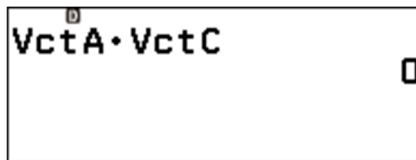


VctA · VctB -9

Now calculate $\overrightarrow{PQ} \cdot \overrightarrow{PR}$ (VctA · VctC).

Note that pressing ← will insert the cursor into the working line, so it can be edited.

So $\overrightarrow{PQ} \cdot \overrightarrow{PR} = 0$, meaning that \overrightarrow{PQ} and \overrightarrow{PR} are perpendicular.

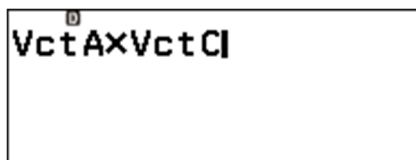


VctA · VctC 0

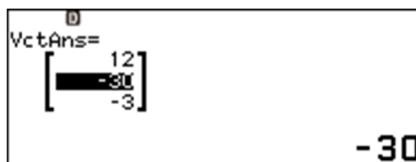
To calculate a vector that is perpendicular to both \overrightarrow{PQ} and \overrightarrow{PR} , we can calculate the vector product (or cross product) of \overrightarrow{PQ} and \overrightarrow{PR} , denoted as $\overrightarrow{PQ} \times \overrightarrow{PR}$ (VctA \times VctC).

Use the 2nd key to enter the \times .

So, $\overrightarrow{PQ} \times \overrightarrow{PR} = (12, -30, -3)$.



VctA \times VctC



VctAns=
[12
-30
-3] -30

Index

- Answer memory, 6, 16, 21
- Argument, 68
- Binomial probability calculations, 66
- Boxplot, 31
- Combinations, 63
- Complex numbers, 68
 - argument, 68
 - cartesian form, 68
 - polar form, 69
- Correlation coefficient, r , 35
- Cross (vector) product, 71
- Cubed roots, 22
- Decimal approximation, 5, 10, 15, 22, 23, 24, 26, 40
- Decimals, 10, 14
- Define a function, 54
- Degrees, 38, 40
- Degrees, minutes and seconds, 38
- delete data, 29
- Deleting data, 28
- Dot (scalar) product, 71
- Exponents, 20
- Factorials, 60
- Financial calculation, 25
- Five number summary, 30
- Fix, 10, 11, 25
- Fraction, 13
- Frequency, 27
- GCD, 46
- Improper fraction, 16
- Initialise, 4
- Interest, 25
- Inverse Normal calculations, 65
- LCM, 44
- Least square line, 34, 35
- y-intercept, 35
- slope, 35
- Letter memories, 18
- Linear Regression, 34
- Logarithms, 26
- MathI / DecimalO, 7
- MathI / MathO, 7
- Mean, 32, 33
- Median, 30
- Memories, 18
- Mixed number, 9, 13, 16, 17, 39
- Norm2, 12
- Normal probability calculations, 64
- Permutations, 62
- Power, 20
- Prime factorisation, 48
- Product function (Π), 53
- Quartile, 30
- Radians to degrees, 43
- Random numbers, 36
- Reset, 4
- Scientific notation, 42
- Shift key, 4
- Solving an equation, 56
- Square root, 22
- Standard deviation, 32, 33
- Statistics application, 27
- Summation, 51
- Table of values, 54
- Tree diagram, 61
- Trigonometry, 40
- Vectors, 70
- Verify, 49
- y-intercept, 35

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