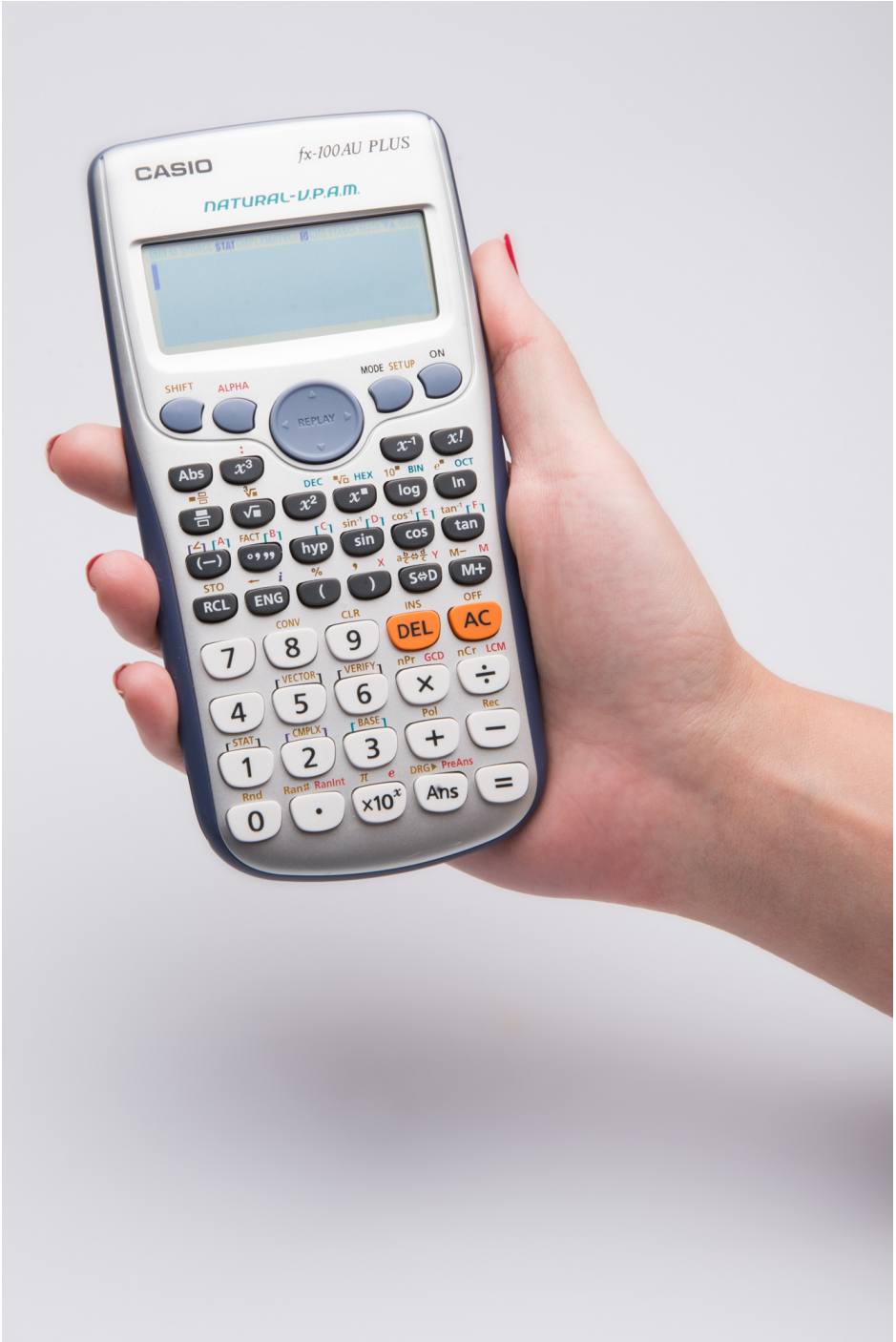
Mastering the calculator: using the Casio *fx*-100AU PLUS



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Contents

Introduction

This is one in a series of calculator booklets prepared to assist students who are learning to use a scientific or financial calculator. They have been prepared by staff in Student Learning and Development from Library Services at USQ. The series comprises:

- Using the Casio *fx*-100s (also suitable for Casio fx-570)
- Using the Casio *fx*-100AU
- Using the Casio *fx*-100AU PLUS
- Using the Casio *fx*-82LB
- Using the Casio *fx*-82MS
- Using the Casio *fx*-82TL
- Using the Casio *fx*-82AU
- Using the Casio*fx*-82AU PLUS
- Using the Sharp EL-531LH
- Using the Sharp EL-556L
- Using the Sharp EL-531RH
- Using the Sharp EL-531WH
- Using the Sharp EL-531XH
- Using the Sharp EL-738F (in press)
- Using the Texas Instruments T130XIIB

The instructions in this booklet only explain **some** of the keys available on your calculator necessary for basic work in data manipulation. If you require more assistance please contact Library Services. If you would like information about other support services available from Library Services, please contact:

Telephone:	1800 063 632 (AU)
Email:	library@usq.edu.au
Home page:	https://library.usq.edu.au

Note the calculator booklets are also available online at the above website.

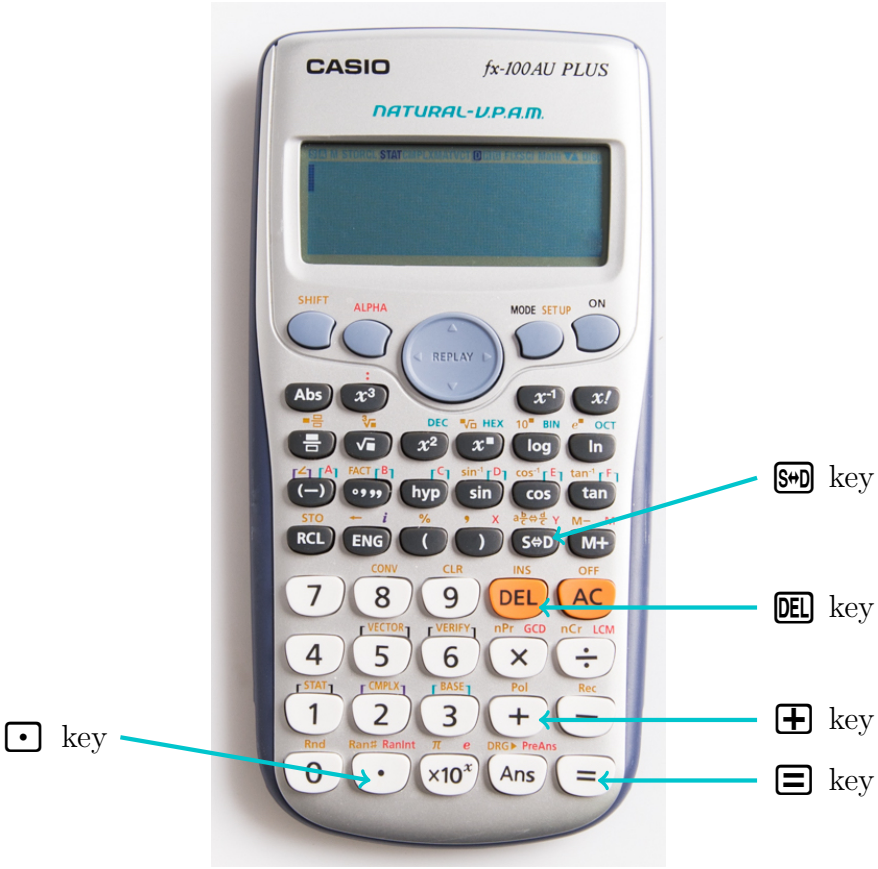
A word about starting out

- Make sure you are in the correct mode selection and that all previous data is cleared. Modes available are:
  - COMP for normal calculations;
  - CMPLX for calculations involving complex numbers;
  - STAT for statistics calculations;
  - BASE-N (not included in this booklet);
  - VERIF (not included in this booklet);
  - VECTOR.
- Example: To perform arithmetic operations press MODE 1.
- To clear all values press AC.
- To clear memory press SHIFT 9 3 =.
- If your calculator has FIX or SCI on the display, to reset your calculator to **normal** mode press SHIFT MODE 8 2.
- If your calculator has R or G on the display then press SHIFT MODE 3 This will put your calculator in Degree mode (a "D" will appear on the screen).
- There is also a mode which gives you a preference for displaying the decimal point as a dot or comma as 34.26 or 34,26. To change this, you press SHIFT MODE then down ▼ once then press 5 (for **display**) then press 1 for dot or press 2 for comma.
- If you are doing normal calculations you should be in Math mode. To be in this mode press MODE 1 and "Math" should appear on the screen.

Chapter 1

Addition and subtraction

1.1 To add numbers



Find the ⊞ key (it is shown on the photograph of the calculator above).

Example 1.1

To add 7 and 3, type

7 + 3 =

The display should read 10.

Example 1.2

To add 7 and 3.1, type

7 + 3 • 1 =

The display will read $\frac{101}{10}$. Press S⇔D to get 10.1.

Example 1.3

I want to find the total amount I earned for the past four weeks. If I earned \$471, \$575, \$471 and \$528, the keystrokes would be:

4 7 1 + 5 7 5 + 4 7 1 + 5 2 8 =

the display should read 2045. This means that the total amount earned over the past four weeks is \$2 045.

1.2 Sometimes you make an error when typing in a number

If this happens use the DEL key to cancel the number and then type in the correct number and continue.

Example 1.4

If you want to enter $3+4$ but accidentally type 3 + 5, press DEL once to cancel the 5. Now type 4 =. The display should now read 7.

Example 1.5

If I want to add 471 and 575, but I typed

4 7 1 + 5 7 6

I can cancel the 6 by pressing the DEL key once and then press 5 =. The display should read 1046.

Try practising cancelling with the DEL key until you are comfortable with its use.

1.3 The REPLAY keys are used when you delete other data

Example 1.6

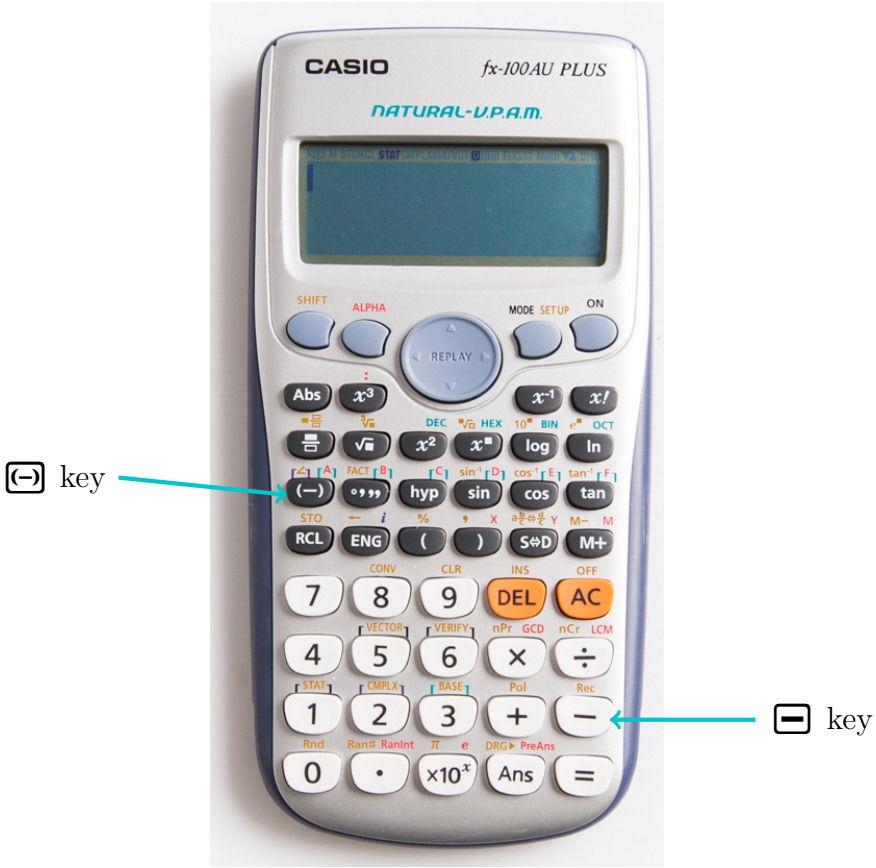
If you typed $471+546$ but you wanted $471+576$. To correct this, press the ◀ key once. Then press DEL once to delete the 4 then press 7. The 7 now replaces the 4. Press =. The display should read 1047.

Practice using this key when replacing digits. Note you can also modify the operation keys $(+, -, \times, \div)$. If you need to change more than one digit you use the DEL key.

You can also use this key to insert anything you omitted.

1.4 To subtract numbers

Find the − key (it is shown on the photograph of the calculator below).



Note: the (−) key is only used for entering negative numbers. Incorrect usage may result in calculation errors occuring.

Example 1.7

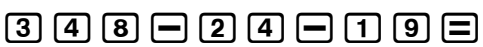
To subtract 35 from 257, type

The display should read 222.

Example 1.8

$$348 - 24 - 19$$

The keystrokes are:



The display should read 305.

Example 1.9

Sometimes you may have a sum like this:

$$-7 + 4$$

You use the  key. The keystrokes are:

The display should read -3.

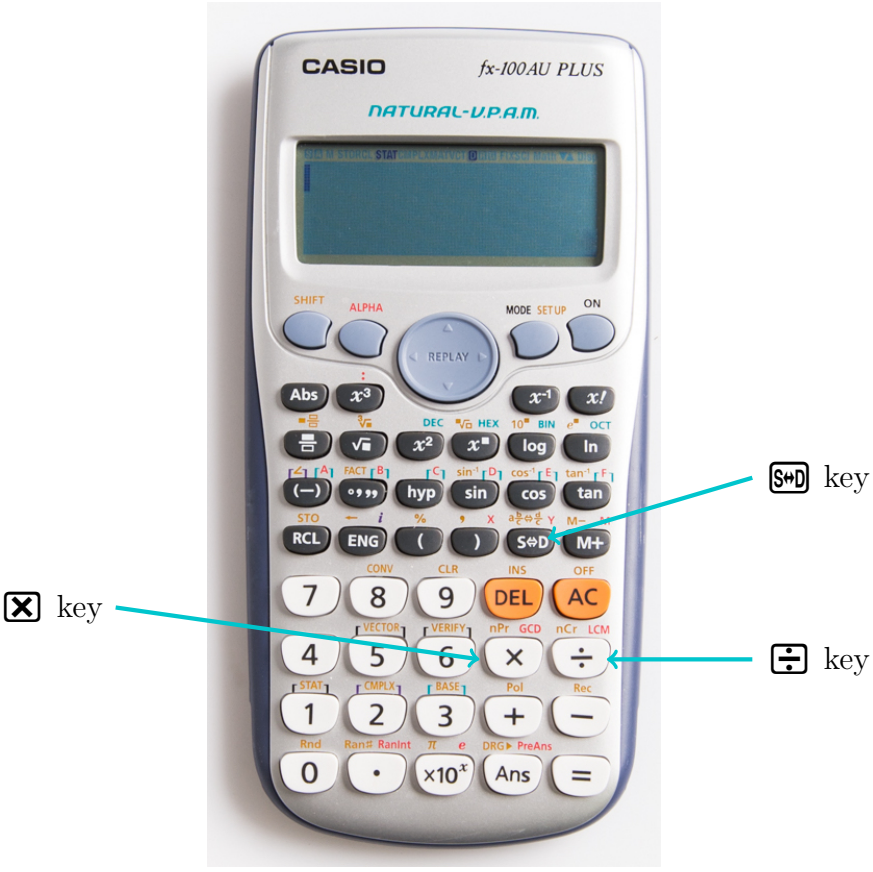
Note: Avoid using the  key to enter negative numbers!

Chapter 2

Multiplication and division

2.1 To multiply numbers

Find the ⊠ key (it is shown on the photograph of your calculator).



Example 2.1

To multiply 7 by 3, type:

[7] [×] [3] [=]

The display should read 21.

Example 2.2

To find 753×492, type

[7] [5] [3] [×] [4] [9] [2] [=]

The display should read 370476.

Find the [÷] key (it is shown on the photograph of the calculator on page 9).

Example 2.3

To divide 35 by 7, type

[3] [5] [÷] [7] [=]

The display should read 5.

Example 2.4

To divide 7 905 by 85, type

[7] [9] [0] [5] [÷] [8] [5] [=]

The display should read 93.

Example 2.5

To divide 56 by 23 947, type

[2] [3] [9] [4] [7] [÷] [5] [6] [=]

The display should read $\frac{8}{3421}$. To display this in decimal form either press [S⇔D] after pressing [=] or

[2] [3] [9] [4] [7] [÷] [5] [6] [SHIFT] [=]

If the display reads 2.33845×10^{-3} or something similar, then your calculator is in SCI mode (Scientific mode). See page 3 to change to COMP mode (Normal Math calculation mode).

2.2 Combining multiplication and division

Example 2.6

If the question is

$$\frac{27}{7 \times 4}$$

then it is really

$$27 \div 7 \div 4\,.$$

Try it.

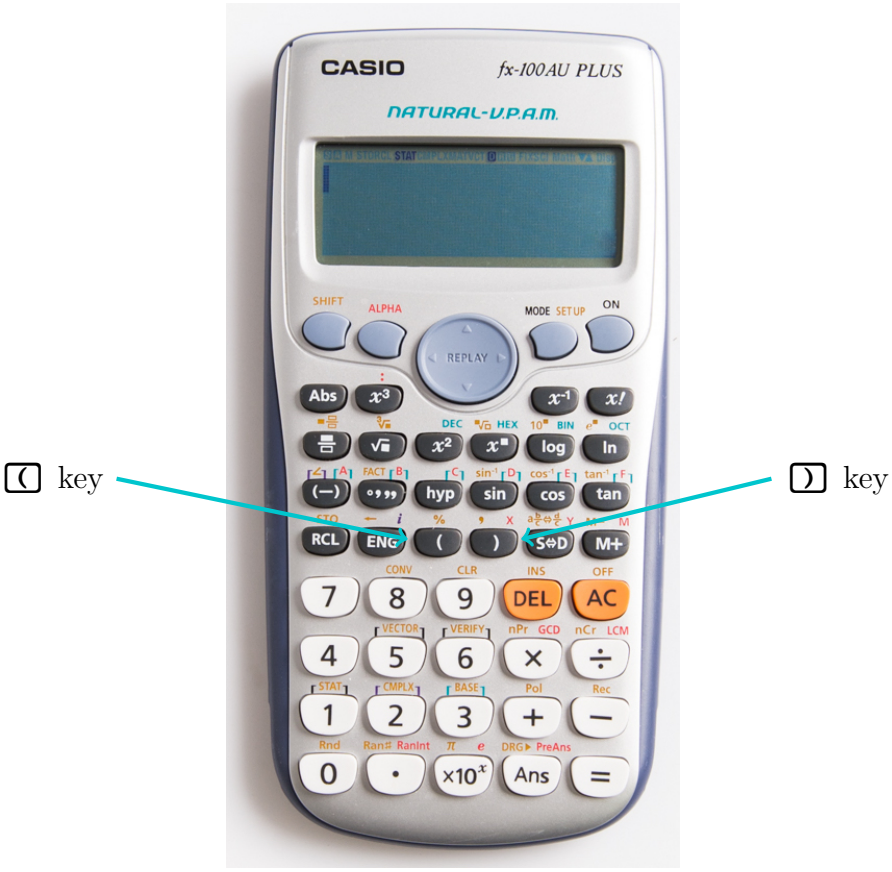
The display should read 0.964285714.

Alternatively, you could use your fraction button to do this type of calculation, see Chapter 5.

Chapter 3

Brackets

Find the bracket keys on your calculator. The *fx*-100AU PLUS allows you to use many sets of brackets.



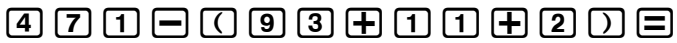
Example 3.1

Do the calculation

$$471 - (93 + 11 + 2)\,,$$

on your calculator. (Make sure your calculation is in COMP (Math) mode MODE 1).

The keystrokes required are:



The display should read 365.

Sometimes in calculations you will see other grouping symbols, for example, { } are called braces, and [ ] are called square brackets.

Try these questions:

Exercise 1

Calculate:

(a) $25 + (7 + 2 - 4)$

(b) $18(3 + 7)$
Note: a multiplication sign is understood i.e. $18 \times (3 + 7)$ but you don't need to press the [×] key.

(c) $4 + 5\,[2\,(3 + 7)]$
Note: to use two sets of brackets just press the same button

(d) $\dfrac{5}{3 + 2}$

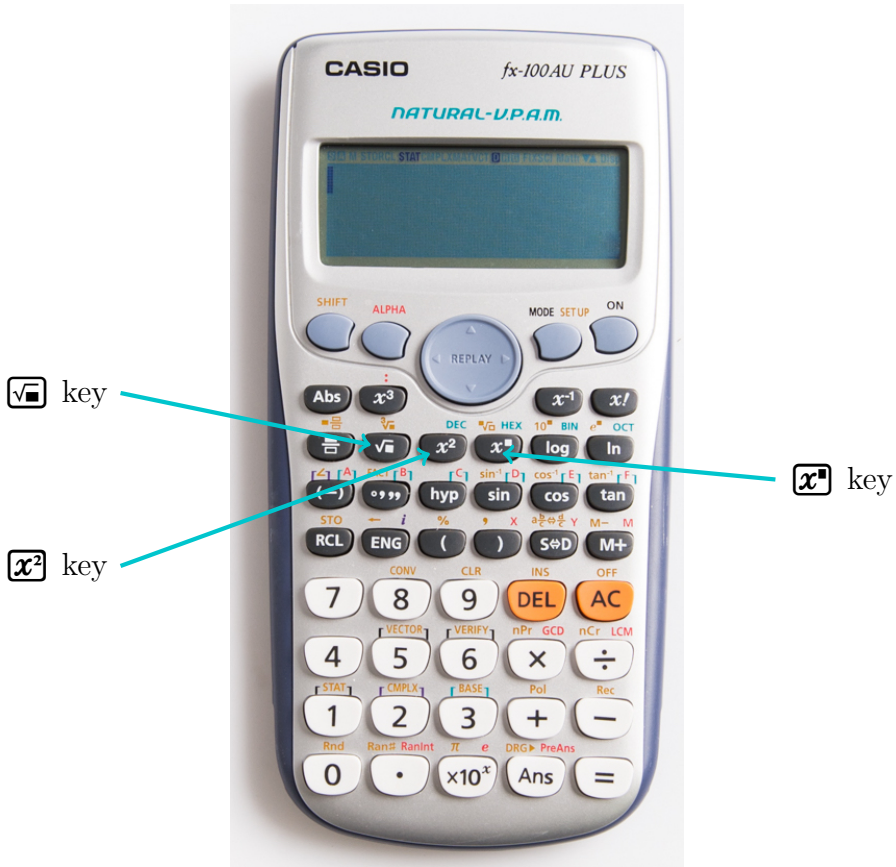
Answers: 30; 180; 104; 1.

Chapter 4

Powers

4.1 Squaring and higher powers

6^2 means 6×6. You can use the square key to do this calculation. (It is shown on the photograph of your calculator here.)



To evaluate 6^2 press [6] [x^2] [=], the display should read 36.

Alternatively, you could use the power key on your calculator. To do this, find the [$x^{\blacksquare}$] key on your calculator.

Example 4.1

To square 6 using the power key, you type:

$$\boxed{6}\ \boxed{x^{\blacksquare}}\ \boxed{2}\ \boxed{=}.$$

The display should read 36.

Example 4.2

To find 27^3 the required keystrokes are

$$\boxed{2}\ \boxed{7}\ \boxed{x^{\blacksquare}}\ \boxed{3}\ \boxed{=},$$

and the display should read 19683.

Exercise 2

Use your calculator to find the square of the whole numbers from 13 to 25 and any other squares you are unsure of:

$1^2 = 1$	$8^2 =$	$15^2 =$	$22^2 =$
$2^2 = 4$	$9^2 =$	$16^2 =$	$23^2 = 529$
$3^2 = 9$	$10^2 =$	$17^2 =$	$24^2 = 576$
$4^2 =$	$11^2 =$	$18^2 =$	$25^2 = 625$
$5^2 =$	$12^2 =$	$19^2 =$	
$6^2 =$	$13^2 =$	$20^2 =$	
$7^2 =$	$14^2 =$	$21^2 =$	

Exercise 3

You can use the $\boxed{x^{\blacksquare}}$ key for other powers as well. Try these examples:

(a) 7^4

(b) 8^{10}

(c) $(0.4)^6$ (You **do not** have to type the brackets in).

(d) $(-7)^6$ (You **need** to type the brackets in).

(e) $5^{0.4}$

(f) 5^{-4}

(g) -4^2

Answers:

(a) 2401

(b) 1 073 741 824

(c) 4.096×10^{-3} or 0.004 096 (You move the decimal place 3 places to the left.) [Remember to press S⇔D if you get a fraction.]

(d) 117 649 (((−) 7) $x^{\blacksquare}$ 6 =)

(e) 1.903 653 939

(f) 0.0016 [Just press 5 $x^{\blacksquare}$ ((−) 4) SHIFT =]

Note: that 5^{-4} is the same as $\frac{1}{5^4}$ so you could also press 5 7 4 = SHIFT to get the same answer.

(g) -16 Note: the-4^2 is interpreted by the calculator as $-(4)^2 = -16$.

4.2 Square root

Finding the **square root** of a number 'undoes' or 'neutralises' the squaring of the number and vice versa. They symbol for the square root is: $\sqrt{\ }$ (this is called the radical sign).

The square root of 36 is written as $\sqrt{36}$.

Now because $6^2 = 36$, $\sqrt{36} = 6$.

Find the square root key on your calculator and type:

$$\sqrt{\blacksquare}\ 3\ 6\ =.$$

The display should read 6.

What do you think $\sqrt{81}$ is? $\sqrt{81} =$

You should have said 9 because $9^2 = 81$. (Check on your calculator.)

What do you think $\sqrt{-49}$ will be? You should have said 'you can not find the square root of a negative number' since you can not find a real number that squares to give a positive. Your calculator will say Math ERROR.

Exercise 4

Try these by looking at the table of squares you completed on page 16.

(a) $\sqrt{16} =$ (c) $\sqrt{100} =$ (e) $\sqrt{49} =$ (g) $\sqrt{121} =$

(b) $\sqrt{144} =$ (d) $\sqrt{441} =$ (f) $\sqrt{169} =$ (h) $\sqrt{361} =$

Answers: 4; 12; 10; 21; 7; 13; 11; 19.

Let's now check that taking the square root neutralises squaring. Try this on your calculator. Find the square root of 3 squared, that is $\sqrt{3^2}$. The keystrokes required are:

$$\boxed{\sqrt{\blacksquare}}\ \boxed{3}\ \boxed{x^2}\ \boxed{=}.$$

The display should read 3.

Because **squaring** and taking the **square roots** are **inverse operations**, the **order** of the operations **can be reversed** and the number is unaffected.

Therefore, the square, of the square root of 3, should also equal 3. Try it on your calculator. The keystrokes required are:

$$\boxed{\sqrt{\blacksquare}}\ \boxed{3}\ \boxed{=}\ \boxed{x^2}\ \boxed{=}.$$

Exercise 5

1. Complete the following without using the calculator:

   (a) $\sqrt{7}^2 =$

   (b) $\sqrt{10^2} =$

   (c) $\sqrt{\square}^2 = 10$

   (d) $\sqrt{\square^2} = 625$

   (e) $\sqrt{\square}^2 = 144$

   (f) $\sqrt{64}^2 = \square$, because $8^2 = \square$

   (g) $\sqrt{121} = \square$, because $\square = 121$

   (h) $\sqrt{225} = \square$, because $\square^2 = \square$

2. Check your answers on the calculator.

Example 4.3

To do the following $\dfrac{8+\sqrt{112}}{8}$, first rewrite it: $(8+\sqrt{112}) \div 8$.

The keystrokes will be:

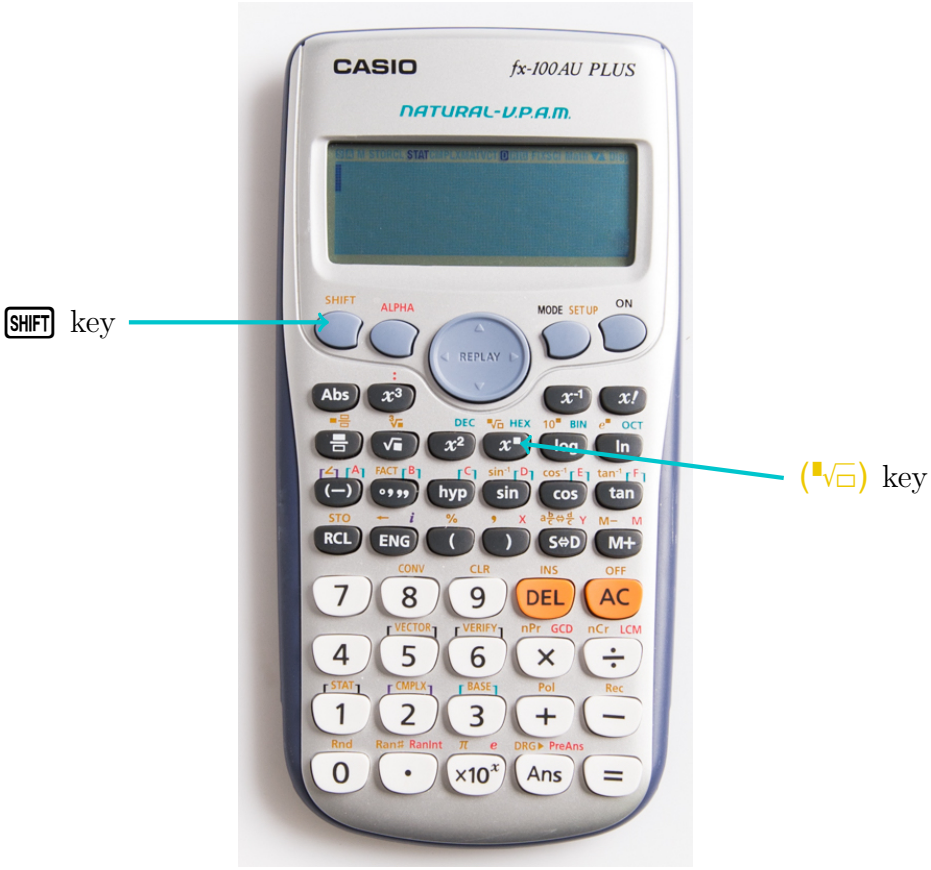
$$\boxed{(}\ \boxed{8}\ \boxed{+}\ \boxed{\sqrt{\blacksquare}}\ \boxed{1}\ \boxed{1}\ \boxed{2}\ \boxed{\blacktriangleright}\ \boxed{)}\ \boxed{\div}\ \boxed{8}\ \boxed{=}.$$

Your answer will be approximately 2.32288 .

You could also use your fraction key to solve this problem (See Chapter 5).

4.3 Other roots

You can also use the root key on the calculator. Find the $\boxed{\blacksquare\sqrt{\square}}$ key on your calculator (it is above the $\boxed{x^{\blacksquare}}$ key). To get this key, you must press $\boxed{\text{SHIFT}}\ \boxed{x^{\blacksquare}}$.



Example 4.4

(a) $9^{\frac{1}{2}}$

Recognising that the power of a $\frac{1}{2}$ is the same as taking the square root, the keystrokes required are:

$$\boxed{\sqrt{\blacksquare}}\ \boxed{9}\ \boxed{=}.$$

The display should read 3.

Alternatively, you could have used:

$$\boxed{2}\ \boxed{\text{SHIFT}}\ \boxed{x^{\blacksquare}}\ \boxed{(\sqrt[\blacksquare]{\square})}\ \boxed{9}\ \boxed{=},$$

and the display should read 3, as before.

(b) $8^{\frac{1}{3}}$

Recognising that $8^{\frac{1}{3}}$ is the same as the taking the cube root of 8, the keystrokes required are:

$$\boxed{\text{SHIFT}}\ \boxed{\sqrt{\blacksquare}}\ \boxed{(\sqrt[3]{\blacksquare})}\ \boxed{8}\ \boxed{=},$$

and the display should read 2.

(c) $16^{\frac{1}{4}}$

Similarly the power of $\frac{1}{4}$ is the same as finding the fourth root, that is, $\sqrt[4]{16}$.

4 SHIFT $x^{\blacksquare}$ ($\sqrt[\blacksquare]{\square}$) 1 6 =,

and the display should read 2.

Note: The root key is found above the power key, that is, you use it by first pressing the SHIFT first.

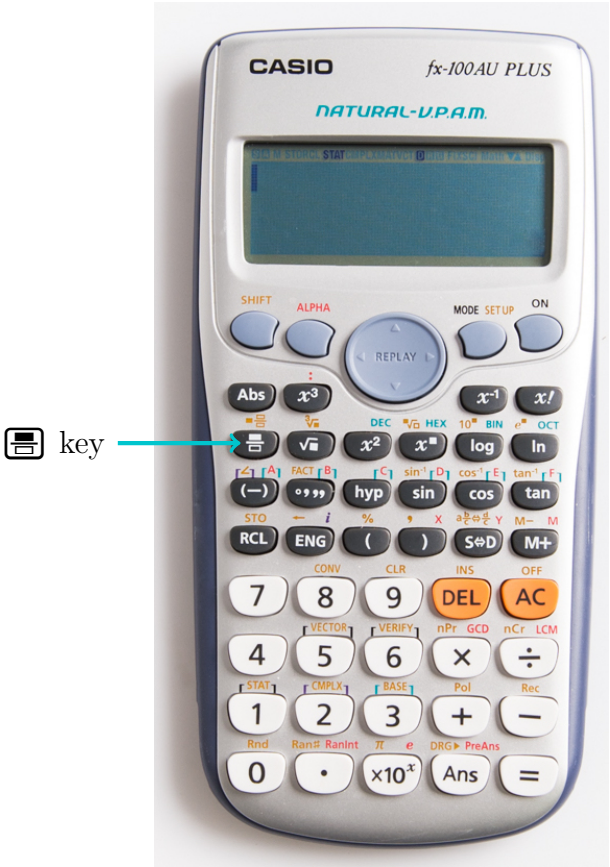
Chapter 5

Fractions

How do you add $\frac{1}{12}$ and $\frac{4}{63}$? Normally you would have to find a common denominator of 252. That is,

$$\frac{1}{12} + \frac{4}{63} = \frac{21}{252} + \frac{16}{252} = \frac{37}{252}\,.$$

Alternatively, you can use your calculator to add these fractions. Find the $\square\!\!\square$ key on your calculator.



To input a mixed number, you need use the fraction above the fraction key, that is SHIFT $\square\!\!\square$ ($\blacksquare\frac{\square}{\square}$). Note that the $\blacksquare$ represents the whole number where the $\frac{\square}{\square}$ represents

the fraction part of the mixed number.

The keystrokes required for the calculation $\frac{1}{12} + \frac{4}{63}$ are:

and the display will show $\frac{37}{252}$.

Example 5.1

Find $8\frac{1}{9} + \frac{63}{72}$.

Using the calculator the keystrokes are:

and the display will show $\frac{647}{72}$. To make this a mixed number you need to now press:  , which gives: $8\frac{71}{72}$. If you press the  key to decimal equivalent is displayed, that is, 8.986111111.

Example 5.2

Calculate complex expressions which involve fractions:

$$30 + \frac{4 \times 35}{1.05\sqrt{40}}\,.$$

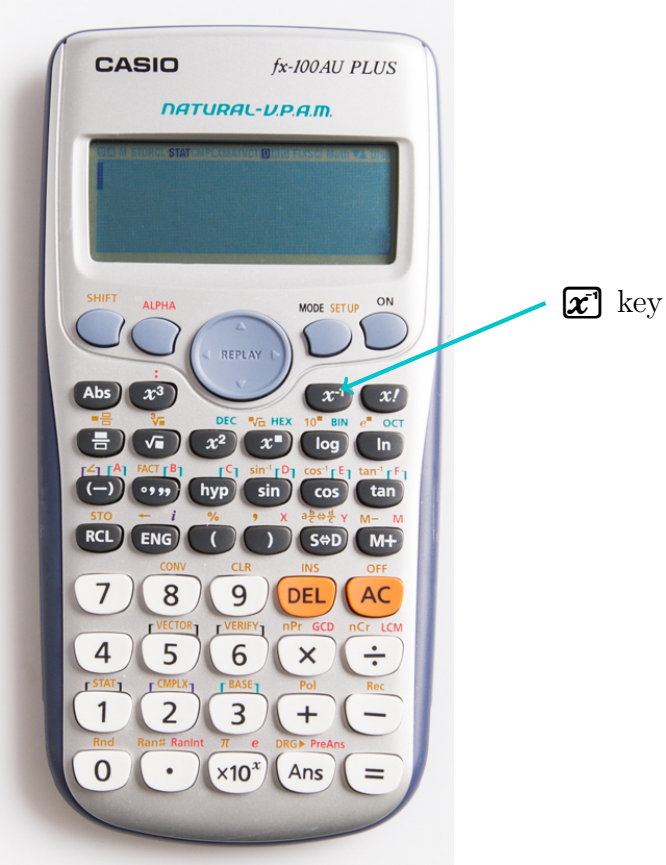
You could do this with example with division and bracket, but you can also use your fraction button to answer this question. The key strokes required are:

 .

You calculator should show: 51.08185107 .

Chapter 6

Using the reciprocal (x^{-1}) key



This is a very useful key in more complex calculations. Find the x^{-1} key on your calculator.

Example 6.1

Look at this simple example: $\frac{4}{7}$ is the same as $4 \times \frac{1}{7}$.

You can input this in your calculator by pressing:

$$\boxed{7}\ \boxed{x^{-1}}\ \boxed{\times}\ \boxed{4}\ \boxed{=}.$$

Your answer should be $\frac{4}{7}$, and press $\boxed{S\leftrightarrow D}$ to get 0.571428571. This is the same as if you just typed $\boxed{4}\ \boxed{\div}\ \boxed{7}\ \boxed{=}$.

Example 6.2

Take another example:

$$\frac{4}{(8+3)\times 7}.$$

To evaluate this, type:

$$\boxed{(}\ \boxed{8}\ \boxed{+}\ \boxed{3}\ \boxed{)}\ \boxed{\times}\ \boxed{7}\ \boxed{=}\ \boxed{x^{-1}}\ \boxed{\times}\ \boxed{4}\ \boxed{=}.$$

The answer should be $\frac{4}{77}$ and then press $\boxed{S\leftrightarrow D}$ to get 0.051948051.

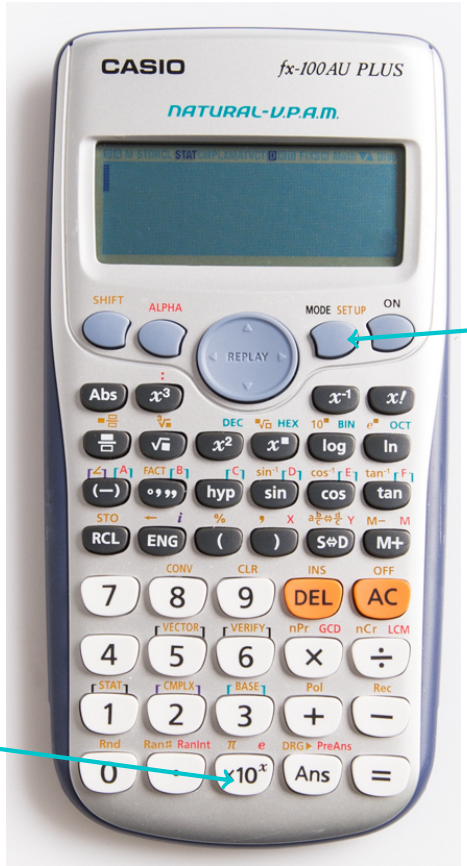
Chapter 7

Scientific notation

Sometimes you may have numbers expressed in scientific notation, that is,

$$7.24 \times 10^3\,,$$

instead of 7240. When a number is multiplied by 10^3, you move the decimal point three places to the right. To complete calculations with scientific notation you can do this on the calculator by using the [×10ˣ] key.



Press

[7] [•] [2] [4] [×10ˣ] [3] [=],

and the display should read 7240 .

Example 7.1

If you want to multiply two numbers in scientific notation

$$8.34 \times 10^{-2} \times 4.28 \times 10^{5}$$

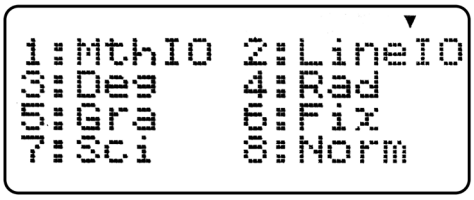
press

[8] [•] [3] [4] [×10^x] [(−)] [2] [×] [4] [•] [2] [8] [×10^x] [5] [=]

and the display will read $\frac{178476}{5}$ then press [S⇔D] to obtain 35695.2 .

If you press [SHIFT] [MODE] then [7] , then [0] [=] the display will read 3.56952×10^4.

Note: Pressing the [SHIFT] [MODE] gives you the display



The [7] puts the calculator in scientific notation. The calculator then asks SCI 0∼9? This gives the option of how many digits are displayed. The [0] gives you 10 digits. Notice a small SCI appears in the screen.

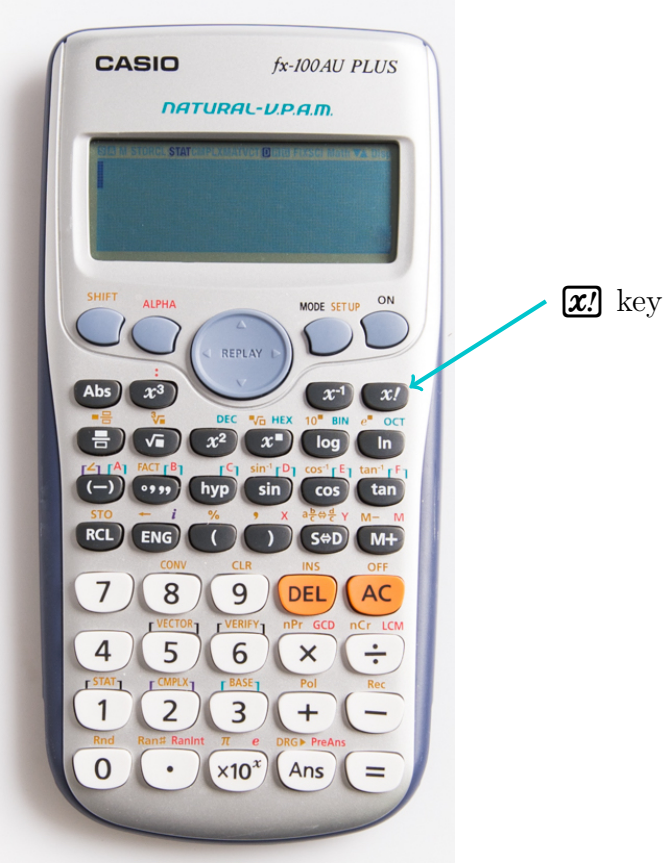
If you press [SHIFT] [MODE] then [7] and then [4] and then [S⇔D] the display will read 3.570×10^4. This rounds the number to 4 digits.

Practise using the [×10^x] and [SHIFT] [MODE] keys on your calculator.

Chapter 8

Factorial $x!$

Look at your calculator and find the key with the symbol $x!$ on it. You will come across this symbol when doing the Binomial Distribution, permutations and combinations. This is called the factorial key.



Example 8.1

Use the factorial key to find 3! and 5! .

To do this you need to press

$$\begin{aligned} 3! &= 3 \times 2 \times 1 = 6 \\ 5! &= 5 \times 4 \times 3 \times 2 \times 1 = 120 \end{aligned}$$

Example 8.2

How many ways would you guess that we could arrange ten people?

That is, how large would you estimate 10! to be? Use your calculator to find 10! You should get 3 628 800 .

$$10! = 10 \times 9 \times 8 \times \ldots \times 3 \times 2 \times 1$$

(Thank goodness this can be done on the calculator!)

Factorial rule

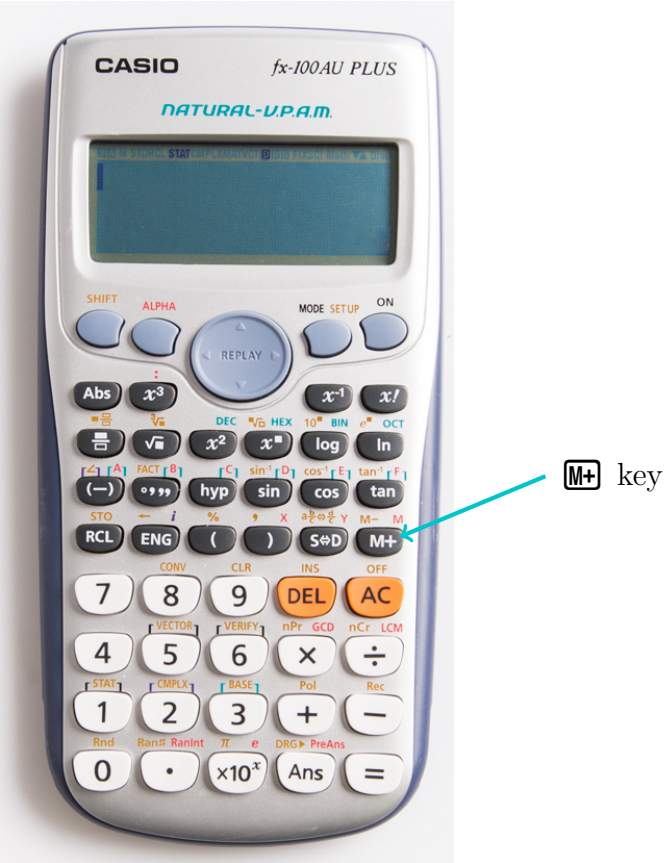
The number of ways of arranging n items in order is known as 'factorial n' which is symbolised as $n!$ where:

$$n! = n \times (n–1) \times (n–2) \times \ldots \times 3 \times 2 \times 1$$

Chapter 9

Using memory

To calculate the following it may be useful to use the memory key for each term:



Example 9.1

$$\frac{(9-16)^2}{16}+\frac{(23-16)^2}{16}+\frac{(17-16)^2}{16} \tag{9.1}$$

Before starting, make sure the memory is clear, press:

[SHIFT] [9] [2] [=] [AC]

An M appears in the display when you put something in memory.

To do the calculation in equation 9.1, press the following keys:

[(] [9] [−] [1] [6] [)] [x^2] [÷] [1] [6] [=] [M+],

this put the first term (3.0625) into the memory. Then press

[(] [2] [3] [−] [1] [6] [)] [x^2] [÷] [1] [6] [=] [M+]

to add the second term (3.0625) into memory. Now press

[(] [1] [7] [−] [1] [6] [)] [x^2] [÷] [1] [6] [=] [M+]

to add the third term to memory. To now find the final answer press [RCL] [M+]. The answer should be 6.1875 $\left(\text{or } \frac{99}{16}\right)$.

Example 9.2

Calculate the following:

$$\frac{18}{\sqrt{17}} + \frac{17}{\sqrt{17}} + \frac{12}{\sqrt{17}}\,.$$

First clear the memory:

[SHIFT] [9] [2] [=] [AC].

Firstly, as the denominators are the same, we will put that into memory:

[$\sqrt{\blacksquare}$] [1] [7] [=] [M+].

Now for the calculations:

[1] [8] [÷] [RCL] [M+] [+] [1] [7] [÷] [RCL] [M+] [+] [1] [2] [÷] [RCL] [M+] [=].

Your answer should be 11.399 174 38 .

There are other memory keys on your calculator, the A, B, C, D, E, F, X, Y pink keys, accessed by using SHIFT, STO, ALPHA and RCL — try them for yourself.

Chapter 10

Statistics

10.1 Mean and standard deviation — single variable data

The formula for the mean is

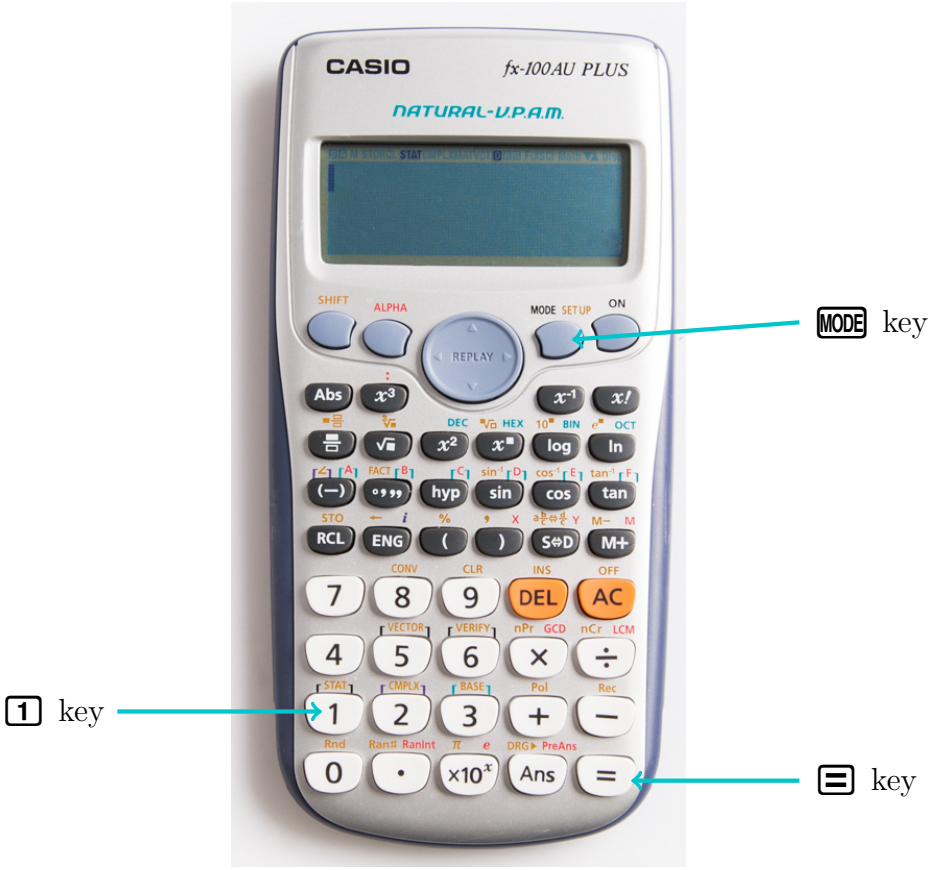
$$\bar{x} = \frac{\sum x}{n}\,.$$

The formulas for the standard deviations are:

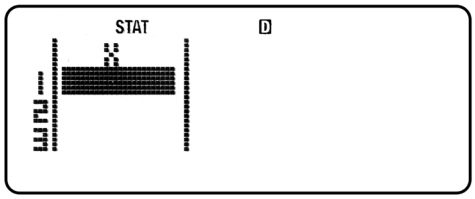
$$\begin{aligned} s_x &= \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}} && \text{(Sample)} \\ \sigma_x &= \sqrt{\frac{\sum (x_i - \bar{x})^2}{n}} && \text{(Population).} \end{aligned}$$

Your calculator will calculate the mean and standard deviation for you (the population standard deviation σ_x or the sample standard deviation s_x — in data calculations you would usually use the sample standard deviation.)

On the Casio *fx*-100AU PLUS, σ and s are found in STAT mode. The positions of keys needed are shown on the diagram on the next page.



To find the mean and standard deviation, firstly you must access the statistics mode of the calculator by using the keys MODE once, followed by 3 and 1. Your screen should look like:



Example 10.1

The data set we will use to to demonstrate the use of the calculator for finding the mean and standard deviation is:

$$-5,\ 2,\ 3,\ 4,\ 11\,.$$

Note: I will show the use of the SHIFT key where necessary.

Step 1: Input the data/observations:

(−) 5 = 2 = 3 = 4 = 1 1 = .

Then press AC to exit the data input screen.

Step 2: To access the statistics menu to find the mean and standard deviation.

Press SHIFT 1 to display the six alternatives:

1: Type	2: Data
3: Sum	4: Var
5: Distr	6: MinMax

Therefore to find the mean, you need to press

SHIFT 1 4 2 =.

The display should read $\bar{x} = 3$.

To find the population standard deviation (σ_x), press

SHIFT 1 4 3 =

which gives, $\sigma_x = 5.099019514$.

To find the sample standard deviation (s_x), press

SHIFT 1 4 4 =

which gives, $s_x = 5.700877126$.

Note: to clear the STAT data, press MODE 3 1 again.

Example 10.2

Use your calculator to find the mean, sample standard deviation and variance for data set:

$$-18,\ 1,\ 3,\ 9,\ 20\,.$$

Note: the variance is the square of the standard deviation. After you are in the statistics mode (and cleared the statistics memories) and inputted the new data set,

- the keystrokes required are to find the mean are

  SHIFT 1 4 2 =

  and the display will read 3.

- To find the sample standard deviation (s_x), press

  SHIFT 1 4 4 =

  and the display will read 13.87443693.

- To now find the variance, press

  x^2 =

  and the display will read 192.5.

Therefore, the mean is 3, the sample standard deviation is approximately 13.87 and

the sample variance is 192.5 .

The SHIFT 1 button accesses a number of extra statistical functions.

- The sum of the data points squared:

SHIFT 1 3 1 =

$$\sum x^2 = 815$$

- The sum of the data points:

SHIFT 1 3 2 =

$$\sum x = 15$$

- The number of data points:

SHIFT 1 4 1 =

$$n = 5$$

If you have made an error with inputting your data you can correct it by going back to the data. Press 1 2 .

For example, you inputted 4, 5, 60, 7, 9 and you meant 6 instead of 60. Go to the data number 3, then press 6 = . You now have the correct data.

10.2 Mean and standard deviation of frequency distribution

In the example below, the progressive calculations are shown simply to give you some understanding of the underlying processes — you should do one or two examples in detail and then check them by calculator.

Example 10.3

Given below is the frequency table for the weights (kg) of a random sample of 30 first year university female students. Find the standard deviation, the variance and the mean.

Graduate's weight (kg)	Frequency	Cumulative frequency
60	2	2
61	14	16
62	8	24
63	1	25
64	5	30

The calculations needed to obtain the standard deviation without statistical keys for these data are:

$$\begin{aligned}\sum x^2 &= 60^2 \times 2 + 61^2 \times 14 + 62^2 \times 8 + 63^2 + 64^2 \times 5 \\ &= 114495 \\ \sum x &= 60 \times 2 + 61 \times 14 + 62 \times 8 + 63 + 64 \times 5 \\ &= 1853\,.\end{aligned}$$

To calculate the mean:

$$\begin{aligned}\bar{x} &= \frac{\sum x}{n} \\ &= \frac{1853}{30} \\ &\approx 61.8\,.\end{aligned}$$

To calculate the sample standard deviation:

$$\begin{aligned}s &= \sqrt{\frac{\sum x^2 - (\sum x)^2/n}{n-1}} \\ &= \sqrt{\frac{114495 - (1853)^2/30}{29}} \\ &= \sqrt{\frac{114495 - 114453.6333}{29}} \\ &\approx \sqrt{1.4264} \\ &\approx 1.194\,.\end{aligned}$$

Therefore, the mean is approximately equal to 61.8 kilograms and the sample standard deviation is approximately equal to 1.2 kilograms.

Note: In calculations like the above you should carry as many decimals as possible until the final result. The number of decimals to be retained at the end depends on the accuracy of the data values — one rule of thumb is to have one more decimal than in the original data.

Notice how the frequencies were used in the above calculation.

The calculator usage now has a small modification because we have been given the frequencies for the variable values. (There is no need to input each single observation.)

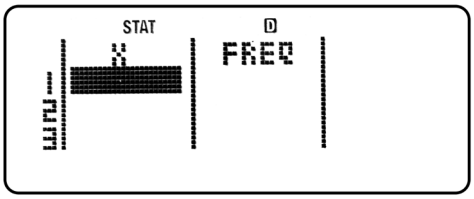
You need to set up your display for inputting frequencies:

Press:

- MODE 3 for STAT mode
- 1 for 1-variable
- SHIFT MODE ▼ 4 for STAT

- [1] to turn frequency ON

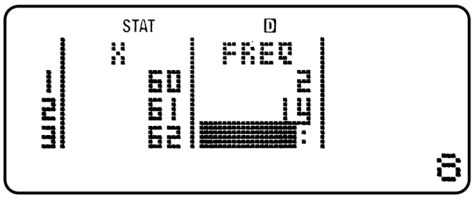
the display should look like this:



Now press:

[6] [0] [=] [6] [1] [=] [6] [2] [=] [6] [3] [=] [6] [4] [=]

Now to put in the frequencies. Move the curser to the FREQ column using the arrow keys on the REPLAY key, and add each frequency followed by the [=] to get a display:



Press [AC] then to find the mean:

[SHIFT] [1] [4] [2] [=]

and the display should read 61.76666667 .

To find the sample standard deviation:

[SHIFT] [1] [4] [4] [=]

and the display should read 1.1943353 .

To find the standard deviation squared (variance):

[x^2] [=]

and the display should read 1.4264369 .

Thus, as expected

$$\begin{aligned} s &\approx 1.2 \text{ kg} \\ s^2 &\approx 1.4 \text{ kg} \\ \bar{x} &\approx 61.8 \text{ kg.} \end{aligned}$$

Exercise 6

Find the mean, standard deviation and variance of

(a) The annual rainfall data for the years 1971–1990:

Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Rain (mm)	1 340	990	1 120	1 736	260	1 100	1 379	1 125	1 430	1 446
Year	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Rain (mm)	1 459	1 678	1 345	978	1 002	1 110	1 546	1 672	1 467	1 123

(b) The sample of snail foot lengths:

Snail foot length (cm)							
2.2	4.1	3.5	4.5	3.2	3.7	3.0	2.6
3.4	1.6	3.1	3.3	3.8	3.1	4.7	3.7
2.5	4.3	3.4	3.6	2.9	3.3	3.9	3.1
3.3	3.1	3.7	4.4	3.2	4.1	1.9	3.4
4.7	3.8	3.2	2.6	3.9	3.0	4.2	3.5

Answers:

(a) Rainfall statistics:

mean: $\bar{x} = 1\,265.3$ mm
standard deviation $s = 336.4$ mm
variance: $s^2 = 113141.7$ mm^2.

(b) Snail statistics:

mean: $\bar{x} = 3.4$ cm
standard deviation: $s = 0.70$ cm
variance: $s^2 = 0.49$ cm^2.

Remember to reset the display with FREQ OFF press SHIFT MODE ▽ 4 2

Chapter 11

Normal distributions

When studying statistics, you will need to standardize scores and find probabilities (area under the standard curve).

Example 11.1

For example, if you had 10 people aged as follows:

$$24\,,\ 21\,,\ 25\,,\ 27\,,\ 23\,,\ 28\,,\ 24\,,\ 24\,,\ 26\,,\ 29\,.$$

Input the values in STAT mode as normal:

[MODE] [3] [1]

[2] [4] [=] [2] [1] [=] ...etc.

To find the standardized score, that is

$$z = \frac{\bar{x} - \mu}{\sigma}$$

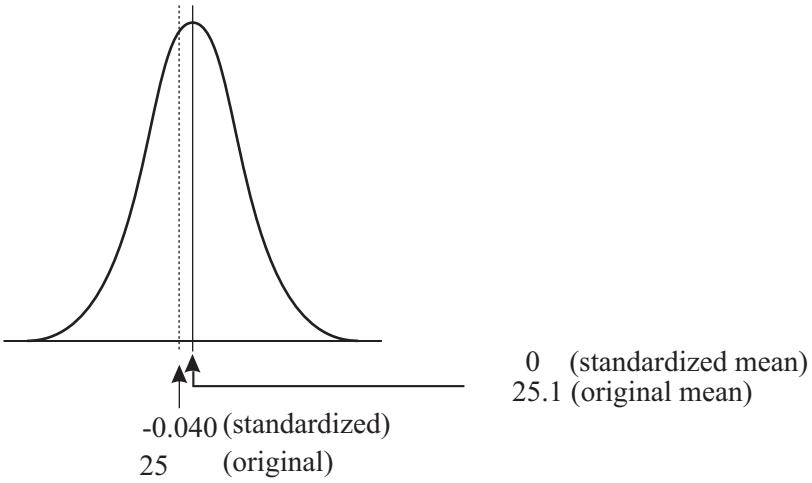
for an age, for example 25.

Press

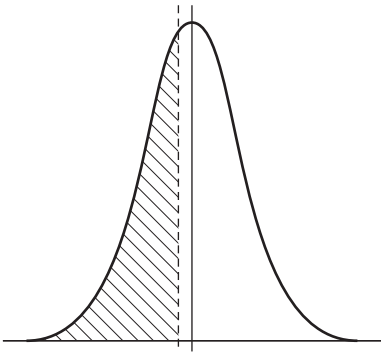
[2] [5] [SHIFT] [1] [5] [4] [=].

The display reads $25 \blacktriangleright t$ (top of the screen) and the display should read -0.04347826087.

This means the value 25 is about -0.04 standard deviations below the mean (25.1).



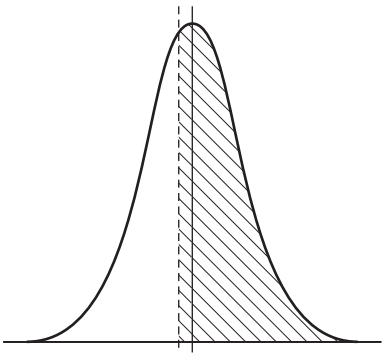
You can find the area under the curve to the left, to the right or between the value and the mean.



To the left press:

SHIFT 1 5 1 (−) 0 • 0 4) =

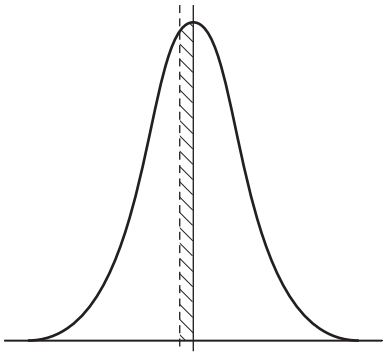
The display reads 0.48405. Therefore, the answer is approximately 0.48 which means $P(x < 25) \approx 48\%$.



To the right press:

SHIFT 1 5 3 (−) 0 • 0 4) =

The display reads 0.51595. Therefore, the answer is approximately 0.52 which means $P(x > 25) \approx 52\%$.



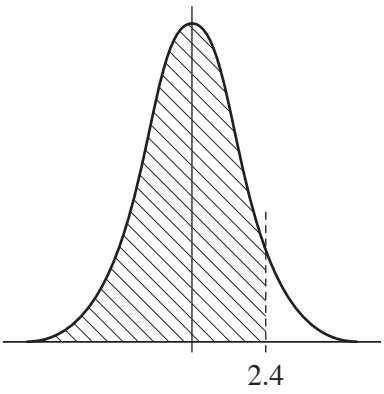
Between the value and the mean press:

SHIFT 1 5 2 (−) 0 • 0 4) =

The answer is approximately 0.016, which means $P(25 < x < \bar{x}) \approx 1.6\%$

Example 11.2

If you just want a probability from a z score, just do the last step. For example, what is $P(z < 2.4)$?



The keystrokes are:

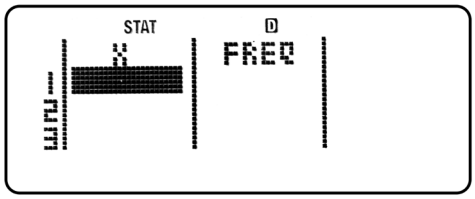
SHIFT 1 5 1 2 • 4) =

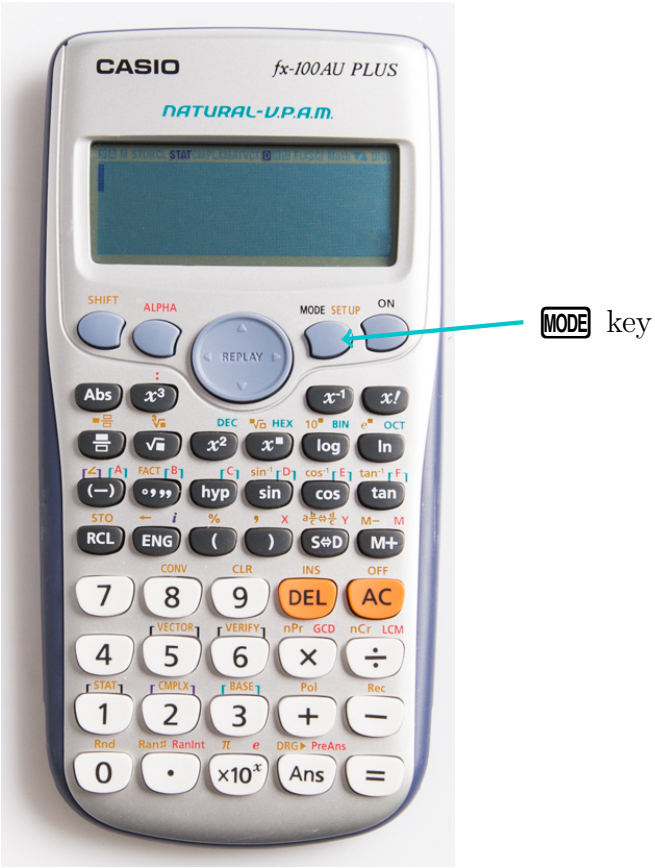
The answer is 0.9918 or about 99%.

Chapter 12

Linear regression

To access the linear regression mode you press MODE key followed by 3 2, the display is shown below.





Example 12.1

Suppose we had a sample of 10 of the same type of banana. Their lengths and skin thicknesses were measured. Below is a summary of the results.

Banana	1	2	3	4	5	6	7	8	9	10
Length (mm)	16.2	15.8	16.5	14.9	16.9	16.8	15.6	15.6	15.7	15.4
Thickness (mm)	1.1	1.2	1.1	1.0	0.9	1.2	1.1	1.2	0.9	0.8

Steps:

1. To put the calculator into regression mode press MODE then 3 2

2. Think of the sample of bananas as having two variables:

   - let x be the variable length of banana
   - let y be the variable thickness of banana

   For each banana you have to put in both numbers.

   To put in the first set of numbers, press the following keys:

   1 6 • 2 = ▶ ▲ 1 • 1 = ◀

   Continue in this manner. Use the REPLAY key to move around the columns.

   After you have input all the numbers, don't forget to press AC.

3. To find the linear regression equation in the form

   $$\hat{y} = a + bx$$

   you need to find the value of a and b. These keys are found under SHIFT 1 5 (for Reg).

   Press:

   SHIFT 1 5 1 =

   thus, $a \approx 0.3651$.

   Press:

   SHIFT 1 5 2 =

   thus, $b \approx 0.0430$.

   Therefore, the equation is

   $$\hat{y} = 0.3651 + 0.0430x$$

   where y is the thickness of the bananas (in mm) and x is the length of bananas (in mm).

4. To find the correlation coefficient press

SHIFT 1 5 3 =

$$r \approx 0.1928$$

There is not a high correlation between the thickness of bananas and the length of bananas tested.

The calculator will also give you other statistics about this sample. Use

SHIFT 1 4

to get the mean or standard deviation for either the length or thickness.

- To find the mean length of bananas:

  SHIFT 1 4 2 =

  which gives:

  $$\bar{x} = 15.94 \text{ mm}.$$

- To find the sample standard deviation of the length of bananas:

  SHIFT 1 4 4 =

  which gives:

  $$s_x \approx 0.6433 \text{ mm}.$$

- To find the mean thickness of bananas:

  SHIFT 1 4 5 =

  which gives:

  $$\bar{y} = 1.05 \text{ mm}.$$

- To find the sample standard deviation of the thickness of bananas:

  SHIFT 1 4 7 =

  which gives:

  $$s_y \approx 0.1434 \text{ mm}.$$

You can also use the SHIFT 1 5 to predict the length, given the thickness. If 0.6 is the thickness then press

0 • 6 SHIFT 1 5 4 = .

The display reads: 5.46625, so therefore predicted length for a banana with thickness of 0.6 mm is approximately 5.47 mm.

Similarly, if the length is 12 mm then press

1 2 SHIFT 1 5 5 =

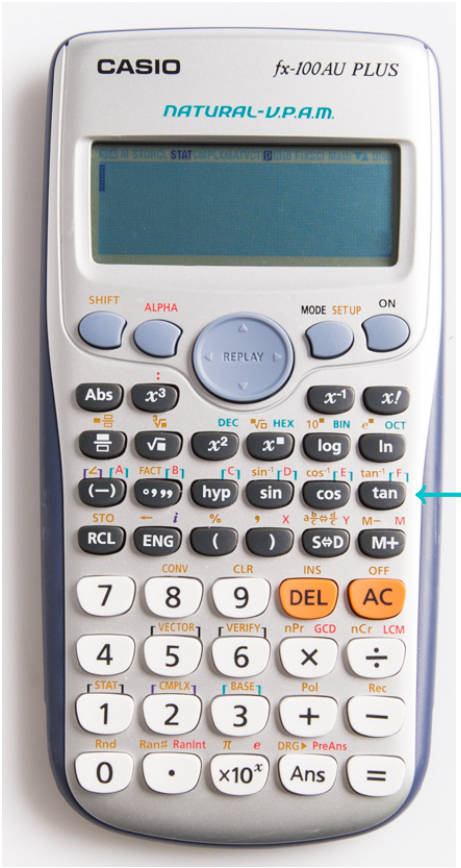
The display reads: 0.8807196563, so therefore predicted thickness for a banana with length of 12 mm is approximately 0.88 mm.

Chapter 13

Trigonometric functions

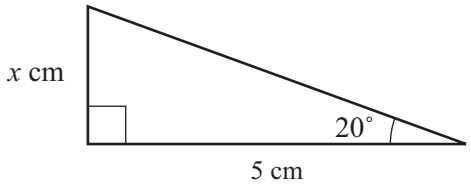
Important: Make sure that your calculator is in the correct mode. For example, if your calculator has R or G on the display and you wish to work in degrees, press SHIFT MODE then select 3 for degrees. Your screen should now display D.

The keys involved are sin cos tan keys as shown in the calculator below:



Example 13.1

In the right-angled triangle below, the length of the side opposite the 20° angle needs to be calculated.



To find the length of the side labelled x cm, use

$$\begin{aligned} \tan 20^\circ &= \frac{x}{5} \\ x &= 5 \tan 20^\circ \end{aligned}$$

The keystrokes on the calculator are:

5 × tan 2 0 =

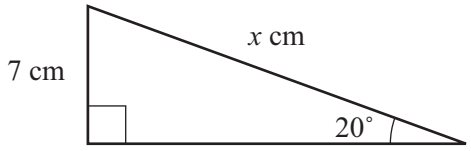
or

tan 2 0) × 5 =

The display should read 1.819851171, so the length of x is about 1.8 cm.

Example 13.2

In the right-angled triangle below, the length of the hypotenuse needs to be calculated.



To find the length of the side labelled x cm, use:

$$\begin{aligned} \sin 20^\circ &= \frac{7}{x} \\ x &= \frac{7}{\sin 20^\circ} \end{aligned}$$

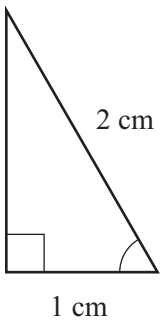
The keystrokes on the calculator are:

7 ÷ sin 2 0 =

The display should read 20.466631, so the length of the hypotenuse is about 20.5 cm.

Example 13.3

Given the lengths of two of the sides in the right-angled triangle below, find the value of the angle θ in degrees



In the diagram,

$$\cos\theta = \frac{1}{2}$$

To find the value of θ, you need to use the $\cos^{-1}$ key. The calculator keystrokes are:

SHIFT COS 1 ÷ 2) =

OR

SHIFT COS ▤ 1 ▼ 2 ▶) =

Note: You must first get the value of the division by using the ( ) brackets, but this calculator automatically inserts the first one for you.

Your display should read 60. If it does not, check that you are in degree mode.

Chapter 14

Exponential and logarithmic functions

There are two log keys on your calculator, with their associated exponential keys. The latter are accessed by first using the shift key:

The log key uses base 10 and the ln key uses base e (natural logarithm).

Example 14.1

Solve equation $2^a = 20$.

Taking logarithms of both sides:

$$\begin{aligned} 2^a &= 20 \\ \log 2^a &= \log 20 \\ a \log 2 &= \log 20 \\ a &= \frac{\log 20}{\log 2}\,. \end{aligned}$$

To find the value of a, the keystrokes are:

[log] [2] [0] [)] [÷] [log] [2] [=]

OR

[▣] [log] [2] [0] [)] [▼] [log] [2] [)] [=]

The display should read 4.321928095.

So, $2^{4.32} \approx 20$. Confirm this by using the [$x^{\blacksquare}$] key.

Example 14.2

Given $\log y = 1.584$, find the value of y.

$$\begin{aligned} \log y &= 1.584 \\ y &= 10^{1.584}\,. \end{aligned}$$

The [$10^{\blacksquare}$] key is above the [log] key. Hence the keystrokes are:

[SHIFT] [log] [1] [•] [5] [8] [4] [=]

The display should read 38.370725 .

Example 14.3

Given $\log_x 6 = 1.5$, find the value of x.

$$\begin{aligned} \log_x 6 &= 1.5 \\ \frac{\log 6}{\log x} &= 1.5 \\ \log x &= \frac{\log 6}{1.5}\,. \end{aligned}$$

To find $\log x$, the calculator keystrokes are:

[log] [6] [)] [÷] [1] [•] [5] [=]

The display should read 0.5187675.

Since this is the value of $\log x$, you still need to find x where $10^{0.5187675}$.

Without removing the answer of 0.5187675 on your display, press:

SHIFT log Ans =

Your display should now read 3.3019272 .

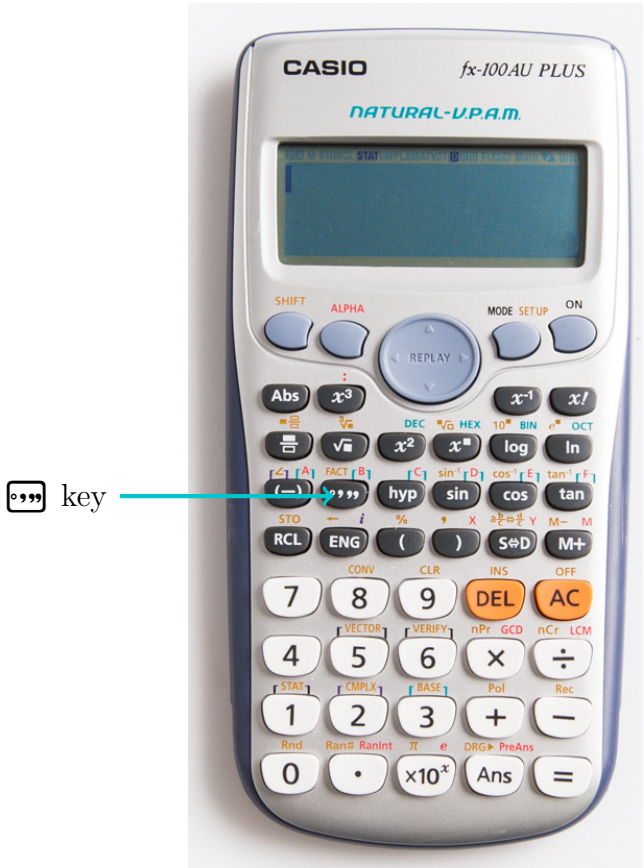
Note: You could use the 'ln' key instead of the 'log' key — the answer would still be the same. Try it!

ln 6) ÷ 1 • 5 = SHIFT ln Ans =

Chapter 15

Degrees, minutes, seconds

The key involved is the °‘“ key.



This key can be used for problems involving degrees, minutes and seconds or hours, minutes and seconds.

Example 15.1

Suppose that you have a trigonometric problem where the angle involved is given in

degrees and minutes. e.g. Find x where

$$x = 4 \times \sin 25°36'$$

The keystrokes involved are:

4 × sin 2 5 °,,, 3 6 °,,, =

The display should show 1.728343, so x is approximately 1.73 .

Example 15.2

If you wish to convert an angle in degrees to its equivalent in degrees, minutes and seconds: e.g. 34.88°, the keystrokes are:

3 4 • 8 8 °,,, =

The display should read 34°52′48″.

Example 15.3

To find the sum of 5 hours 52 minutes 30 seconds and 7 hours 45 minutes 49 seconds: The keystrokes are:

5 °,,, 5 2 °,,, 3 0 °,,, + 7 °,,, 4 5 °,,, 4 9 °,,, =

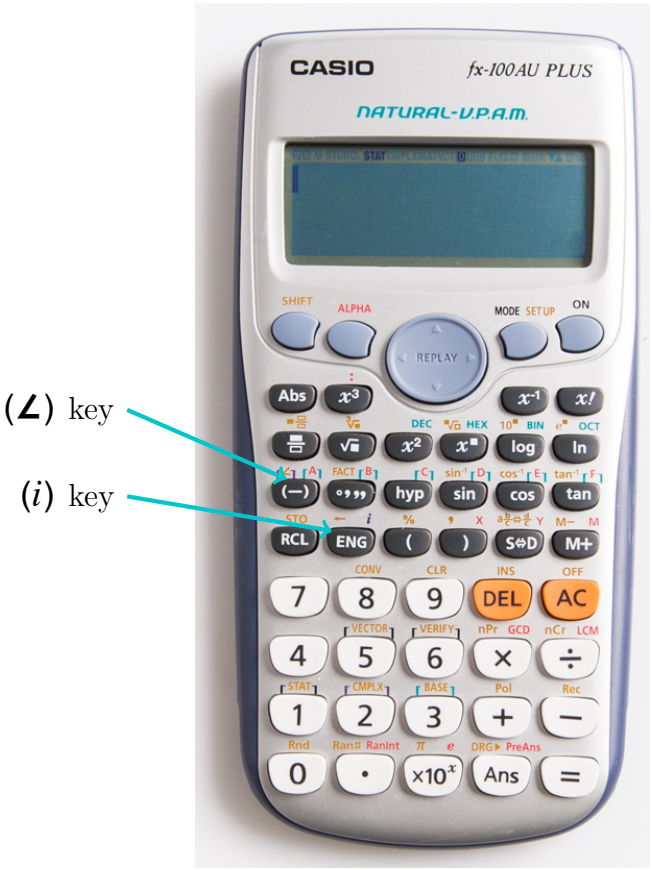
The display should read 13°38′19″.

Press °,,, and the display should read 13.63861111.

Chapter 16

Complex numbers

Use the MODE key to enter CMPLX mode when you want to perform calculations that include complex numbers. Note, that the current angle setting (Deg, Rad, Gra) affects this mode.



You can use either rectangular $(a+bi)$ or polar $(r\angle\theta)$ co-ordinates to input complex numbers.

You can set your calculator complex number format:

SHIFT MODE ▼ 3 1 for $a+bi$ format

SHIFT MODE ▼ 3 2 for $r\angle\theta$ format.

Example 16.1

Calculate: $(2 + 3i) + (4 + 5i)$

The keystrokes required are:

(2 + 3 ENG (i)) + (4 + 5 ENG (i)) =

the display reads: $6 + 8\mathbf{i}$.

To convert this to polar form you need to press:

SHIFT 2 3 =

The display reads: $10\angle 53.13010235$. This means that the modulus (length) is 10 and the argument (angle) is approximately 53°. Note, for this calculation you need to make sure you calculator is in degree mode (SHIFT MODE 3) otherwise the argument will be given in radians instead of degrees.

Example 16.2

Convert: $z = 2\sqrt{2}\angle 135$ from polar form to rectangular form.

Make sure your calculator is in $a + bi$ format (SHIFT MODE ▼ 3 1), then to input the complex number:

2 $\sqrt{\blacksquare}$ 2 ▶ SHIFT (−) $(\angle)$ 1 3 5 =

The top of the screen should read $2\sqrt{2}\angle 135$. The answer will be: $-2 + 2i$.

Example 16.3

To convert $\sqrt{2} - \sqrt{2}i$ to $r\angle\theta$ format.

1. Firstly change the complex number format to be the one you require the answer in: SHIFT MODE ▼ 3 2 for $r\angle\theta$ format.
2. Input the complex number

$\sqrt{\blacksquare}$ 2 ▶ − $\sqrt{\blacksquare}$ 2 ▶ ENG (i) =

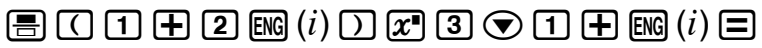
The display reads: $2\angle -45$

Example 16.4

Evaluate:

$$\frac{(1 + 2i)^3}{1 + i}$$

The keystrokes required are:



The screen should read:

$$-\frac{13}{2}+\frac{9}{2}i$$

or $-6.5+4.4i$.

Review calculator exercises

1. Perform the following calculations:

   (a) $(5+4)\times 3$

   (b) $12.5 - 8 \div 0.5$

   (c) $\dfrac{3\times 6-8}{4}$

   (d) $\dfrac{7\times 0.41+17}{(4+7)\times 2}$

   (e) $\dfrac{12.8}{16.5-3.8}$

   (f) $\dfrac{2.4}{\frac{3}{4}}$

   (g) $\sqrt{145.6-\dfrac{17.2^2}{5}}$

   (h) $\dfrac{\sqrt{345.6-17.2^2}}{5}$

   (i) $25+\dfrac{3\times 27}{1.02\sqrt{30}}$

   (j) $(4.1333-3.000)\pm 2.015\sqrt{\dfrac{0.1366^2}{6}+\dfrac{0.2000^2}{6}}$

   (k) $\dfrac{(100-90)^2}{90}+\dfrac{(50-60)^2}{60}+\dfrac{(20-30)^2}{30}$

2. The following data is on growth (in \$m) in an economy over a 8 year period:

   2.5 6.2 -2.1 0.04 8.2 7.4 2.1 -1.7

   Calculate:

   (a) $\sum x$ (b) $\sum x^2$ (c) $(\sum x)^2$

   Explain in words what each of these mean.

Calculator solutions

1. (a) $(5+4)\times 3 = 27$

   (b) $12.5 - 8 \div 0.5 = -3.5$

   (c) $\dfrac{3\times 6 - 8}{4} = 2.5$

   (d) $\dfrac{7\times 0.41 + 17}{(4+7)\times 2} = 0.9$

   (e) $\dfrac{12.8}{16.5 - 3.8} = 1\dfrac{1}{127} \approx 1.0079$

   (f) $\dfrac{2.4}{\frac{3}{4}} = 3.2$

   (g) $\sqrt{145.6 - \dfrac{17.2^2}{5}} \approx 9.2969$

   (h) $\dfrac{\sqrt{345.6 - 17.2^2}}{5} \approx 1.4109$

   (i) $25 + \dfrac{3\times 27}{1.02\sqrt{30}} \approx 39.4985$

   (j) $(4.1333 - 3.000) \pm 2.015\sqrt{\dfrac{0.1366^2}{6} + \dfrac{0.2000^2}{6}} \approx 0.9341$ or 1.3325

   Note, you have to do both the subtraction (minus) an the addition (plus)

   (k) $\dfrac{(100-90)^2}{90} + \dfrac{(50-60)^2}{60} + \dfrac{(20-30)^2}{30} = 6\dfrac{1}{9} \approx 6.1111$

2. (a) $\sum x = 22.64$

   (b) $\sum x^2 = 178.4016$

   (c) $(\sum x)^2 = 512.5696$

Your notes