

Using a scientific calculator



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Introduction

The course describes some of the main features of a scientific calculator and encourages you to use your calculator, both for everyday arithmetic and for more complicated calculations that use the function keys as well. Key sequences, which describe which keys to press, are included in all the activities, so you can try out the ideas straightaway. Due to the wide range of scientific calculators available, for the purposes of this course we will be concentrating on the Casio fx-83ES model. Other calculators may function differently to the methods described within this course.

This calculator is used on the Open University courses [Starting with maths \(Y182\)](#) and [Discovering mathematics \(MU123\)](#), but would also be useful for many other courses requiring the use of a scientific calculator.

This OpenLearn course is an adapted extract from the Open University course [MU123 Discovering Mathematics](#).

Learning Outcomes

After studying this course, you should be able to:

- understand the basic functions on your calculator
- understand which calculator functions are needed for a given problem
- understand what may go wrong when entering calculations and know how to fix them
- apply knowledge of calculator functions to a range of mathematical calculations.

1 Getting to know your calculator

The first 11 sections describe how to use the calculator and how to perform different types of calculations. Section 12 contains a calculator reference guide that you can refer to as needed for some of the main key sequences.

This course is not an exhaustive list of all the calculator's features. If you are using a different calculator, you should use the corresponding features of your own calculator to do the activities in this guide. You may need to refer to your calculator manual to do this.

You may be able to download the manual for your calculator from the manufacturer's website.

The first step in using your calculator effectively is to make sure that you are familiar with the layout of the keys on the keypad, and that you can understand the information on the display.

Figure 1 shows the different parts of the Casio fx-83ES calculator.

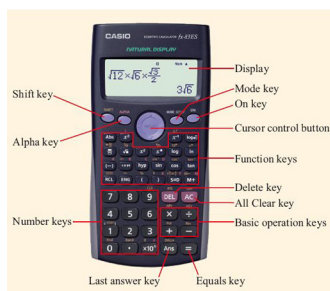



Figure 1 A typical scientific calculator

If you are using a different model of calculator, make sure that you can identify similar functions on your model.

The calculator is switched on using the  key at the top right-hand corner of the keypad. Figure 2 shows the different elements of this calculator's display.

Throughout this section, calculator keys will be indicated using the symbol on the key enclosed in a box, for example .

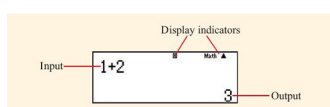











Figure 2 The calculator display

The lower half of the keypad contains the number keys, keys for the basic operations of addition, subtraction, division and multiplication, and the  key, which is pressed when you want the calculator to display the result of the calculation you have entered. The keys   used to insert brackets into a calculation are in the centre of the row above the number keys.

Many keys on the calculator have more than one use. The main function of a key is printed in white on the key itself. The second function of the key is printed in yellow above the key, and is accessed by pressing the  button before pressing the key. When you

press the  button, the symbol  appears at the top left-hand corner of the calculator display to remind you that the button has been pressed. It disappears when you press another key. Some keys also have a third function, printed above the key in red. These functions allow numerical values stored in the calculator memories to be used

within calculations and are accessed by pressing the  button before the appropriate key. When the  button is pressed, the symbol  is shown at the top of the calculator display. You will learn how to use the calculator memories later in section 4.

The calculator manual describes this second function as the 'alternate' function of the key.

Some calculator operations are accessed through a system of menus that are displayed on the calculator screen, as shown in Figure 3. The required menu option is selected by pressing the number key associated with the option, as given on the calculator screen.

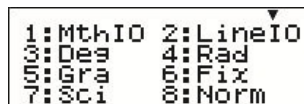






Figure 3 A typical calculator on-screen menu

When describing how to use various calculator functions, this guide gives the exact keys that you need to press using the symbols shown *on* the keys. This is known as a 'key sequence'. If the key sequence accesses the second function of a key, or a function from a menu, the name of this function will be given in brackets at the appropriate point in the key sequence. Names in brackets are thus not keys that you press but simply describe the function that is accessed using the previous key sequence. For example, to turn off

the calculator, press   (OFF). In this notation, (OFF) is not a key that you press, but is the name of the second function of the  key, which is accessed with the  key.

The calculator has many modes of operation that affect how mathematics is entered and displayed. These will be described later in this guide, but before progressing any further you should reset your calculator to the default course settings.

Activity 1 Initialising your calculator

To initialise your calculator to the default course settings, turn it on and then enter the following two key sequences:

SHIFT **9** (CLR) **1** (Setup) **=** (Yes) **AC**
SHIFT **MODE** (SETUP) **8** (Norm) **2**

Note that in the first key sequence, 'CLR' (which is short for 'clear') is the second function of the **9** key, and 'Setup' is the name of the on-screen menu option corresponding to the **1** key. 'Yes' is the name of the on-screen menu option corresponding to the **=** key. This key sequence clears all previous 'setup' settings on the calculator.

In the second key sequence, 'SETUP' is the name of the second function of the **MODE** key, and 'Norm' (short for 'normal') is the on-screen menu option corresponding to the **8** key. Pressing the key **2** selects to use 'Normal 2' mode, which will be described in more detail in section 5.

Note the difference between 'SETUP', the second function of the **MODE** key, and the menu option 'Setup'.

Your calculator will now be working in 'Math' mode, and the word Math will be shown near the right-hand side of the top of the calculator display, as shown in Figure 4 below. Math mode is the recommended way of using your calculator during this course as it allows mathematics to be entered and displayed in a similar way to how you would write it on paper.

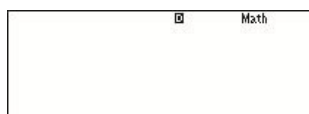


Figure 4 'Math' mode

1.1 Basic calculations

Basic calculations are entered into the calculator in exactly the same order as they are written on paper, as demonstrated in the following activity. The calculator displays the



calculation that you enter. When you press **=**, the answer is displayed at the bottom right of the screen.



Activity 2 Sums, differences, products and quotients



Use your calculator to work out the answers to the following calculations.


1. $1492 + 87 \times 127$
2. $3038 \div 98 - 27$
3. $57 \times (1293 - 981)$
4. $(10175 + 1234) \times (56789 - 45968)$

Answer

1. $1492 + 87 \times 127 = 12541$ Note that the calculator uses the **BIDMAS** rules. These say that any expression within **B**rackets should be calculated first, then any **I**ndices (often called powers), followed by **D**ivisions and **M**ultiplications and finally **A**dditions and **S**ubtractions.
2. $3038 \div 98 - 27 = 4$
3. $57 \times (1293 - 981) = 17784$ To calculate this correctly you need to remember to insert the brackets into the calculation using the   keys.
4. $(10175 + 1234) \times (56789 - 45968) = 123456789$

You may have noticed that in part (4) of the above activity, the calculation was too long to fit on the calculator display. In such circumstances, the symbols  or  appear at the left or right of the display to indicate that there is more information in that direction. This





information can be seen by scrolling left or right using the  and  keys, which are found at the left and right sides of the large cursor control button (labelled with the word 'REPLAY') located under the calculator screen.

If you type a very long calculation into your calculator, then you may see the cursor (which is usually shown as '|') change to . This means that you are allowed to type only at most 10 more characters. If you encounter this, you should break your calculation into smaller parts.

The cursor is a flashing symbol indicating where the next item entered into the calculator will appear.

1.2 Fractions or decimals?

In Activity 1 you set up your calculator to use Math mode. In this mode, when the result of a calculation is not a whole number, it will be displayed as a fraction, such as $\frac{3}{4}$, wherever possible.

To obtain the answer in decimal form, you need to press   instead of , or you can toggle between the fractional and decimal outputs using the  key.


Remember, your calculator is in Math mode if the word Math is shown at the top of the calculator display. If your calculator is not in Math mode, repeat the steps of Activity 1.

Activity 3 Fractions and decimals





Use your calculator to find $2397 \div 13209$ in both fractional and decimal forms.







Answer

In Math mode, calculating $2397 \div 13209$ gives the result $\frac{47}{259}$.

Converting this to a decimal using  gives 0.1814671815.

1.3 Powers

There are several keys on the calculator that enable you to perform calculations involving powers. For small powers such as squares or cubes there are dedicated buttons,  and , which are located in the function key area of the keypad. These are used in a similar manner to how you would write mathematics; for example, to enter 3^2 you would press  . The display also shows the maths in the same way as you would write it on paper.

To calculate higher powers, for example 2^5 , you need to use the more general power key . This is again used in a natural way. To enter 2^5 , you use the key sequence   . Note that after you press the  key, a small box is shown on the calculator display containing the flashing cursor (‘|’), which enables you to enter the power in the correct place. To move the cursor away from this box and back to the main line of the display once the power has been entered, press the right arrow key  at the right-hand side of the large cursor control button.

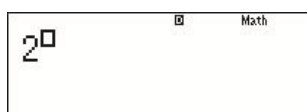






Figure 5 The general power key function



Other models of calculator may have the button  instead of  and may not have specific  and  keys.

Activity 4 Calculating powers

Calculate each of the following using your calculator.






1. 192^2
2. 23^6
3. $5^8 + 1.4^5$


Answer

1. $192^2 = 36864$
2. $23^6 = 148035889$ Here you need to use the general power key .
3. $5^8 + 1.4^5 = 390630.3782$ Remember to use the right arrow key  after inputting the power 8 to move out of the power position before entering the rest of the expression. If you obtained the answer 2243822356, you have calculated $5^{8+1.4^5}$ by mistake.

1.4 Making corrections




If you make a mistake when entering a key sequence into the calculator, you can use the editing facilities to correct your error.

The  and  keys on the large cursor control button enable you to move the cursor (shown on the display as '|') within a calculation on the calculator screen. Characters can then be inserted at the cursor location simply by pressing the appropriate buttons, and items to the left of the cursor can be deleted using the  key. This can be done either before or after the  key has been pressed. To re-evaluate an edited calculation, simply press  at any time.

In some circumstances, however, it may be easiest to abandon what you have typed and start again, by pressing the 'all clear'  key!

If a severe error is made when entering a calculation into the calculator, it may prevent the answer being calculated at all, as the calculation may not make mathematical sense. In

such circumstances a 'Syntax Error' will be displayed as shown in Figure 6. The Syntax Error screen gives you two options:

- Press  to abandon the calculation and clear the screen
- press either  or  to return to the erroneous calculation with the editing cursor placed at the point of the error, ready for a correction to be made

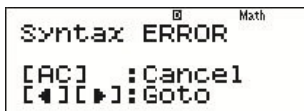


Figure 6 Syntax Error

Other types of calculator error that you may encounter are:

- 'Math Error', when the calculation you entered makes mathematical sense but the result cannot be calculated, such as attempting to divide by zero, or when the result is too large for the calculator to handle.
- 'Stack Error', when your calculation is too complex to be handled in one go – in such circumstances, try to break the calculation into a number of simpler ones.

Section 4 considers how you might do this.

In these cases, the calculator will display a screen similar to that for the Syntax Error, allowing you to either abandon or correct your calculation.

Activity 5 Making corrections

Enter the following key sequence into your calculator in an (erroneous) attempt to

calculate $(1 + 3)^2$:



What should the correct answer be, and why does this key sequence not give it?

Use the calculator editing functions to correct the inputted key sequence.

Answer

The correct value of $(1 + 3)^2$ is 16. The key sequence given did not close the bracket before squaring the expression, so only the 3 was squared, giving $1 + 3^2 = 1 + 9 = 10$.

When correcting the expression, be careful to ensure that the cursor is immediately after the 3, and the same height as it – shown below – before inserting the missing bracket. Otherwise, the bracket may be inserted within the power.

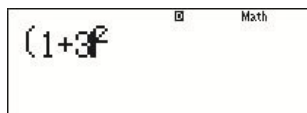






Figure 7 The cursor, placed after the 3



2 Using your calculator for negative numbers


There are two different mathematical uses for the minus sign (-):



- as the symbol for subtraction, as in $5 - 3$
- to indicate a negative number such as -2 .

Corresponding to these there are two different minus sign keys on the calculator:

- , which is used for the operation of subtraction, as in 
- , which is used for negative numbers, e.g. .

In fact, some calculators permit the  key to be used for both purposes, but many other calculators require the equivalent of the  key to be used for negative numbers.

For this reason we shall use  to input negative numbers throughout this guide.



Note that if you attempt to use  for subtraction, for example , you will generate a Syntax Error.

Activity 6 Subtraction and negative numbers

Calculate each of the following using your calculator. In each case, give your answer as a decimal not as a fraction.

1. $-213.6 + 58.8$
2. $315.12 + (-142.26)$
3. $37.4 - (-25.2) + (-4.7)$
4. $13.5 \times (-22.9)$
5. -56^2

Answer

1. $-213.6 + 58.8 = -154.8$ Remember to press   to obtain a decimal answer.
2. $315.12 + (-142.26) = 172.86$
3. $37.4 - (-25.2) + (-4.7) = 57.9$

4. $13.5 \times (-22.9) = -309.15$

5. $-56^2 = -3136$

You may have been surprised that the correct answer to part (5) is negative. According to the BIDMAS rules, the squaring is performed first, then the negative taken. If we wanted to calculate the square of -56 , we write this mathematically as $(-56)^2$ and would need to use the brackets when evaluating it on a calculator.

3 Using your calculator for fractions

When your calculator is in Math mode, as recommended, fractions are entered using the



button in the left-hand column of the function key area of the calculator keypad. This displays a fraction 'template' on the display – as shown in Figure 8 below – that contains boxes that need to be 'filled in'. When the button is first pressed, the cursor is located in the top box ready for you to enter the numerator. To move to the bottom box to enter the

denominator, use the cursor down key . If there are further parts of a calculation to be





entered when the template has been completed, the right cursor key  can be used to move out of the denominator in preparation for the input of the rest of the calculation.



Figure 8 A fraction template

Remember, your calculator is in Math mode if the word Math is shown at the top of the calculator display. If your calculator is not in Math mode, repeat the steps of Activity 1.

Mixed numbers such as $1\frac{2}{3}$ can be entered similarly using the mixed number template

obtained using the key sequence   . This template provides three boxes to fill, one for the whole number part, and one each for the numerator and denominator of the fractional part.

Any fractional answers to calculations will automatically be displayed in lowest terms.

Activity 7 Fractions


Use your calculator to:


1. express $\frac{2568}{252}$ in its simplest form
2. calculate $\frac{3}{8}$ of 190.

Answer

1. $\frac{2568}{252} = \frac{214}{21}$

2. $\frac{3}{8}$ of 190 can be written $\frac{3}{8} \times 190$, which is equal to $\frac{285}{4}$ or 71.25.









The decimal answer can be obtained by using .


Remember to use the cursor right key  to move the cursor out of the denominator of the fraction before entering the multiplication sign. If you obtained the answer $\frac{3}{1520}$, you calculated $\frac{3}{8 \times 190}$ by mistake.

You may have noticed that the results of both these exercises were displayed on the calculator as top-heavy fractions. This is the default behaviour of the calculator in Math mode. You can toggle between a top-heavy fraction and its mixed number equivalent

using the key sequence   $(a\frac{b}{c} \leftrightarrow \frac{d}{c})$.

The default behaviour of the calculator can be changed as follows:

- To set the calculator to use mixed numbers by default, use the key sequence   (SETUP)   (ab/c).
- To set the calculator to use improper or top-heavy fractions by default, use the key sequence   (SETUP)   (d/c).





Here, the  key is used to access part of the on-screen menu that is not initially visible.

Activity 8 Mixed numbers

Use your calculator to:

- express $\frac{2568}{252}$ as a mixed number in its simplest form
- express $113\frac{27}{31}$ as a top-heavy fraction.

Answer

- $\frac{2568}{252} = 10\frac{4}{21}$ Remember to use   $(a\frac{b}{c} \leftrightarrow \frac{d}{c})$ to toggle between the top-heavy fraction and mixed number answers.
- $113\frac{27}{31} = \frac{3530}{31}$ Remember to use the template obtained using   $(\frac{\square}{\square})$ and to use the cursor arrow keys to move between the boxes when inputting the mixed number.

4 Doing longer calculations using your calculator

The volume of wood (in cubic metres) contained in a log of length L metres with a distance around its middle of D metres is given by the formula

$$V = \frac{L \times D^2}{4\pi}.$$


For a log of length 1.5 m with a distance around the middle of 92 cm, this becomes

$$V = \frac{1.5 \times 0.92^2}{4\pi}.$$

In this section we consider several different approaches that can be used to evaluate this and other more complex expressions using different functions on your calculator. While the first method – considered in Activity 9 – is probably the most straightforward for this relatively simple expression, it is useful to see how you might use other calculator functions when you are faced with more complicated expressions to evaluate.

The expression for the volume of wood requires the value of π . You could enter an approximate value for π by hand, but this is time-consuming and may be prone to error. The calculator has an approximation for π built into it, which is obtained using the key

sequence   (π) .

The  key is located on the bottom row of the keypad.

Activity 9 Using the fraction key

$$V = \frac{1.5 \times 0.92^2}{4\pi}$$

The most obvious way of calculating $\frac{1.5 \times 0.92^2}{4\pi}$ is to enter it as a fraction on your calculator.

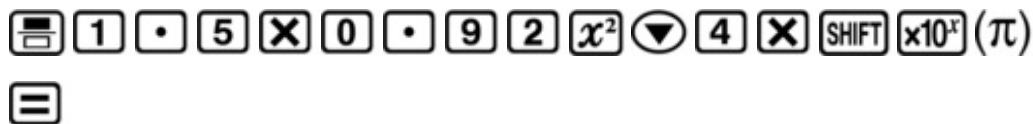
What key sequence is needed, and what is the final answer to 3 significant figures?

Answer

$$\frac{1.5 \times 0.92^2}{4\pi} = 0.101$$

(to 3 significant figures).

The key sequence used was



Note that it is not strictly necessary to include the multiplication between the 4 and the π in the denominator since if the sign is omitted, it will be assumed by the calculator.

Another way to carry out the calculation in Activity 9 is to use the  key.


Activity 10 Using the key

You will not obtain the correct answer to the calculation


$$\frac{1.5 \times 0.92^2}{4\pi}$$

if you type

$$1.5 \times 0.92^2 \div 4 \times \pi$$

into your calculator and press . Can you explain why? Insert a pair of brackets into the expression with the \div sign so that it will give the correct answer. Then type this new expression into the calculator and check that you obtain the same answer as in the activity above.

Answer

Typing $1.5 \times 0.92^2 \div 4 \times \pi$ into the calculator and pressing  will not give the correct answer because the calculator will follow the BIDMAS rules and divide 1.5×0.92^2 by 4 and then multiply by π , instead of dividing by 4π .

To obtain the correct result, you have to type $1.5 \times 0.92^2 \div (4 \times \pi)$. (Alternatively, you can type $1.5 \times 0.92^2 \div 4 \div \pi$.)

(Note that on some later models of the calculator, the correct answer is obtained without adding the brackets to the denominator; however it is good practice to add the brackets to ensure the correct calculation is carried out).

4.1 Reusing a previous result


An alternative approach to our calculation is to calculate the denominator of the fraction first, and then divide the numerator by this.

You could write down the answer to the first part of the calculation on paper, and enter it into the calculator again. However, it is possible that you may make an error either in writing down the number or in typing it into the calculator. A better method is to use the fact that the calculator retains the last calculated answer, which can then be inserted in

the subsequent calculation using the  key located at the bottom of the keypad.

Note that the  key only remembers the result of your *last* calculation.

Activity 11 Bottom first!

Use your calculator to calculate the value of the denominator of $\frac{1.5 \times 0.92^2}{4\pi}$, then complete the calculation by finding the value of $1.5 \times 0.92^2 \div$  to 3 significant figures.

Answer

The value of the denominator is 12.566..., and the final answer is 0.101 to 3 significant figures.

4.2 Using the calculator memory


A variation on the above method is to break the calculation into two parts, and use the memory functions of the calculator to store the result of the first part. The calculator memory is particularly useful when you want to calculate the values of several expressions that have a common part. This common part need be entered only once and

its value reused several times subsequently. For example, rewriting the formula for the volume of wood contained in a log as






$$V = L \times D^2 \times \frac{1}{4\pi},$$

we can see that no matter what the values of L and D , the formula always requires the value of $\frac{1}{4\pi}$. If we wished to calculate the volume of wood contained in several different logs, it might be efficient to calculate the value of $\frac{1}{4\pi}$ once, store it in memory and reuse this value in the subsequent calculations.

The calculator has several different memories. We shall first consider the 'M' memory,






which is accessed using the  key (and its associated functions) at the bottom right-hand corner of the function key area.




Before using the calculator memory, it is good practice to always clear any previous data









stored in the calculator using the key sequence   (CLR)  (Memory)  (Yes) .

Note that this clears *all* the calculator memories.

To store the result of an expression just calculated (i.e. an answer displayed in the output area of the calculator screen) in the 'M' calculator memory, use the key sequence

  (STO)  (M). Here we are using the second function of the  (or recall) button, which is called 'STO' (or store). After selecting the store function, we need to tell the calculator which memory the value is to be stored in. These memories are labelled in red on some of the calculator keys, and the 'M' memory is obtained by pressing the  key. We could read the key sequence as 'store the current result into the M memory'.

Once  (or   (STO)) has been pressed, the display indicator RCL (or STO) is shown on the display to indicate that the calculator is waiting to know which memory to recall (store) the value from (in).


To display the current contents of the 'M' memory, press   (M). The value stored in memory can also be used as part of a subsequent calculation by inserting the 'letter' M into the appropriate point of the expression using   (M). For example, to find the square of the value currently stored in the 'M' memory, M^2 , we can use the key sequence   (M)  .

When there is a value stored in the 'M' memory, the display indicator M is shown at the top of the display.

Activity 12 Using memory

Store the value of $\frac{1}{4\pi}$ in the 'M' memory of the calculator and then use this stored value to evaluate $1.5 \times 0.92^2 \times \frac{1}{4\pi}$ to 3 significant figures.

Answer

The value of $\frac{1}{4\pi}$ (which equals 0.0796 to 3 significant figures) can be calculated using  **1** **▼** **4** **SHIFT** **x10^x** **(π)** **=** and stored in the 'M' memory using the key

sequence **SHIFT** **RCL** **(STO)** **M+** **(M)**.

This value can then be used to find the final result using

1 **.** **5** **x** **0** **.** **9** **2** **x²** **x** **ALPHA** **M+** **(M)** **=**, which gives 0.101 to 3 significant figures, as expected.

4.3 Other 'M' memory operations

The value stored in the 'M' memory can also be changed by adding or subtracting the result of a further calculation:

- To add the result of the latest calculation to the value currently in the memory, press **M+** ..
- To subtract the value of the latest calculation from the value currently in the memory, use the key sequence **SHIFT** **M+** **(M-)**.

Expressions can also be stored in, added to or subtracted from the memory at the same

time as they are evaluated by replacing the **=** at the end of a calculation with one of the memory access sequences. For example, to calculate $43 - 16$ and store the result

straight into the memory, use the key sequence **4** **3** **-** **1** **6** **SHIFT** **RCL** **(STO)** **M+** **(M)**.


To clear the 'M' memory alone, simply store the value 0 in it using the key sequence



0 **SHIFT** **RCL** **(STO)** **M+** **(M)**.

4.4 Other memories

The calculator also has 6 other memories, labelled 'A', 'B', 'C', 'D', 'X' and 'Y', which are accessed using several of the keys in the lower half of the function key area of the calculator. Each memory name is printed in red above the key used to access it.

These memories can be used in exactly the same way as the 'M' memory, except that

there are no equivalents to the 'add to memory' () and 'subtract from memory'

( ) (M-) functions, and no display indicators.

5 Scientific notation on your calculator

Displaying numbers in scientific notation on your calculator

If the result of a calculation is a number greater than or equal to 10^{10} (i.e. 10 000 000 000), the calculator will automatically display the result using scientific notation. For example, calculating 5^{25} gives the answer $2.980232239 \times 10^{17}$,

which is displayed on the calculator screen as it is written here.

Small numbers are also automatically displayed using scientific notation. However, how small the number needs to be for this to happen depends on the mode the calculator is working in:

- 'Norm 1' mode uses scientific notation for any number less than 0.01 but greater than -0.01 .
- 'Norm 2' mode uses scientific notation for any number less than 0.000000001 but greater than -0.000000001 .

'Norm' is short for 'normal'.

In Activity 1 you will have already set your calculator to use Norm 2 mode, and we suggest that for the moment you continue to use this. To change the mode, use the key sequence

SHIFT **MODE** (SETUP) **8** (Norm) followed by **1** (for Norm 1) or **2** (for Norm 2).








You can also set the calculator to *a*lways display results using scientific notation with a set

number of significant figures using the key sequence **SHIFT** **MODE** (SETUP) **7** (Sci)

followed by the number of significant figures required, for example **3**. When your calculator is set in this fashion, the display indicator SCI is displayed at the top of the screen. To cancel such a setting, use one of the key sequences given above to return to a 'Norm' mode.

5.1 Inputting numbers in scientific notation to your calculator

Numbers expressed in scientific notation can be input directly to the calculator by using

the  key on the bottom row of keys. For example, 1.23×10^4 can be entered using the key sequence      .

Activity 13 Calculating with scientific notation

Use the scientific notation functions of your calculator to calculate each of the following, giving your answer in both scientific and ordinary forms.

1. $8.123 \times 10^4 + 4.34 \times 10^3$
2. $3.87 \times 10^4 \times 3.34 \times 10^{-6}$
3. $(7.5 \times 10^{12}) \div (3.2 \times 10^6)$

Answer

1. $8.123 \times 10^4 + 4.34 \times 10^3 = 8.557 \times 10^4$ or 85570
2. $3.87 \times 10^4 \times 3.34 \times 10^{-6} = 1.29258 \times 10^{-1}$ or 0.129258
3. $(7.5 \times 10^{12}) \div (3.2 \times 10^6) = 2.34375 \times 10^6$ or 2343750

6 Powers and surds on your calculator

Inputting fractional and negative powers

In Activity 4 you saw how to use the x^{\square} key to input powers on the calculator. The x^{\square} key can be used with other functions, such as the fraction template $\frac{\square}{\square}$, to calculate fractional and negative powers.

Activity 14 Calculating more powers

Calculate each of the following using your calculator, giving your answer correct to 3 significant figures.

1. $192^{\frac{1}{3}}$
2. $23^{\frac{3}{16}}$
3. $2.4^{-1.2}$

Answer

1. $192^{\frac{1}{3}} = 5.77$ (to 3 significant figures) using the key sequence $\boxed{1}\boxed{9}\boxed{2}\boxed{x^{\square}}\boxed{\frac{\square}{\square}}\boxed{1}\boxed{\nabla}\boxed{3}\boxed{=}$.
2. $23^{\frac{3}{16}} = 1.80$ (to 3 significant figures) using the key sequence $\boxed{2}\boxed{3}\boxed{x^{\square}}\boxed{\frac{\square}{\square}}\boxed{3}\boxed{\nabla}\boxed{1}\boxed{6}\boxed{=}$.
3. $2.4^{-1.2} = 0.350$ (to 3 significant figures) using the key sequence $\boxed{2}\boxed{\cdot}\boxed{4}\boxed{x^{\square}}\boxed{(-)}\boxed{1}\boxed{\cdot}\boxed{2}\boxed{=}$.

6.1 Using roots on your calculator

Just as there are keys on your calculator for entering powers, roots can also be entered directly. Square roots can be calculated using the $\sqrt{\square}$ key. For example, $\sqrt{2}$ can be entered using $\boxed{\sqrt{\square}}\boxed{2}$. Cube roots are entered using the second function of this key. For higher roots, such as fourth or fifth roots you need to use the more general $\sqrt[n]{\square}$

template, which is the second function of the x^{\square} key. This template is filled in by using the number and arrow keys (\leftarrow and \rightarrow) in a way similar to that used when the fraction template is completed.

Activity 15 Calculating roots

Calculate each of the following using your calculator, giving your answer correct to 3 significant figures.

1. $\sqrt{1258}$

2. $\sqrt[3]{56}$

3. $\sqrt[6]{217}$

4. $\sqrt{338}$

Answer

1. $\sqrt{1258} = 35.5$ (to 3 significant figures) using the key sequence $\sqrt{\square} \ 1 \ 2 \ 5 \ 8 \ =$.

2. $\sqrt[3]{56} = 3.83$ (to 3 significant figures) using the key sequence $\text{SHIFT} \ \sqrt{\square} \ (\ \sqrt[3]{\square} \) \ 5 \ 6 \ =$.

3. $\sqrt[6]{217} = 2.45$ (to 3 significant figures) using the key sequence $\text{SHIFT} \ x^{\square} \ (\ \sqrt{\square} \) \ 6 \ \rightarrow \ 2 \ 1 \ 7 \ =$.

4. $\sqrt{338} = 13\sqrt{2}$ or 18.4 (to 3 significant figures) using the key sequence $\sqrt{\square} \ 3 \ 3 \ 8 \ =$ (and using $\text{SHIFT} \ =$ to find the decimal result).

You will notice from the result of Activity 15, part 4 that the calculator sometimes presents answers using surds.

This is true only if the calculator is in the recommended Math mode.

To find the decimal equivalent of an answer like this, you can use the $S \div D$ or

$\text{SHIFT} \ =$ keys that you used earlier to find the decimal forms of fractional answers.

6.2 Inserting a missing root

Sometimes when entering into your calculator an expression involving roots, you may accidentally forget to press the appropriate function key. However, moving the cursor to the correct point and pressing the missing key, as in section 1, will not work as this simply inserts an empty template.




If you wish to edit an expression to insert a missing root, first move the cursor to the correct place – that is, to the left of the number. Then activate the 'Insert' function by

pressing   (INS), and finally press the appropriate root key.

7 Trigonometric ratios on your calculator

There are various different units in which an angle can be measured, degrees being one of the possibilities. Before using your calculator to find the values of the trigonometric ratios of angles measured in degrees, you need to ensure that it is set to use the correct units.

Always check that your calculator is using the correct system of angle measurement before using trigonometric ratios.

Your calculator is set to use degrees if the display indicator  is shown at the top of the screen. If you see the indicator  or , then your calculator is set to use different units for measuring angles.

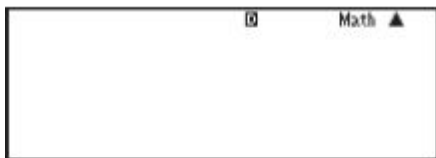









Figure 9 The degrees setting




To set your calculator to work in degrees, use the key sequence

  (SETUP)  (Deg).

To calculate the sine, cosine or tangent of an angle, press the ,  or  key and then type in the size of the angle. Note that the ,  and  keys automatically open a bracket for you. If you are simply calculating the sine, cosine or tangent of an

angle, just press  after entering the angle – there is no need to close the bracket. If you are using these ratios as part of a larger calculation, then you will need to remember

to close the bracket yourself (by pressing ) before entering the remainder of the calculation.

Some older models of calculator require the angle to be input first, followed by the ,  or  button.

Activity 16 Trigonometric ratios on your calculator

Calculate the value of each of the following using your calculator, giving your answers correct to 3 significant figures.

1. $\sin 7^\circ$
2. $\cos 71^\circ$
3. $\sin 45^\circ$
4. $\tan 55^\circ$
5. $2 \sin 20^\circ + 5$
6. $(\sin 56^\circ)^2 + (\cos 56^\circ)^2$

Answer

1. $\sin 7^\circ = 0.122$ (to 3 significant figures). If you got 0.657, then your calculator is currently set to calculate in radians, so reset it to work in degrees using **SHIFT** **MODE** (SETUP) **3** (Deg).
2. $\cos 71^\circ = 0.326$ (to 3 significant figures).
3. $\sin 45^\circ = \frac{\sqrt{2}}{2}$ or $\frac{1}{\sqrt{2}}$ or 0.707 (to 3 significant figures).
4. $\tan 55^\circ = 1.43$ (to 3 significant figures).
5. $2 \sin 20^\circ + 5 = 5.68$ (to 3 significant figures).

Remember to close the bracket that pressing **sin** opens before entering the '+5'. If you obtained the answer 0.845 (to 3 significant figures), you probably calculated $2 \sin(20^\circ + 5^\circ) = 2 \sin 25^\circ$ instead.

Note that when entering this expression in your calculator, it is possible to omit explicitly entering the multiplication between the 2 and $\sin(20^\circ)$ since the calculator will assume it.

6. $(\sin 56^\circ)^2 + (\cos 56^\circ)^2 = 1$

Note that $(\sin 56^\circ)^2$ means first find the sine of 56° , then square the answer.

The key sequence to enter $(\sin 56^\circ)^2$ into the calculator is thus




(**sin** **5** **6** **)** **)** **x²**. The first **)** is necessary to close the

bracket automatically opened when pressing **sin**, and the second closes the bracket opened at the start of the sequence. Since the calculator evaluates the sine as soon as it encounters the first closing bracket, it is possible to enter this

expression using the alternative sequence **sin** **5** **6** **)** **x²**, but this is not recommended as the former is more clear.

It is a property of trigonometric ratios that for *any* angle θ , $\sin^2 \theta + \cos^2 \theta = 1$.

You will notice from the answer to part (3) that the calculator displays the ratios of some angles as fractions, involving surds where needed, and not in decimal form.

The decimal form can be found using   or  .

8 Finding angles from trigonometric ratios

Inverse trigonometric values can be found using the second functions \sin^{-1} , \cos^{-1} and \tan^{-1} of the **sin**, **cos** and **tan** keys. These functions are used in a similar manner to **sin**, **cos** and **tan**.

Activity 17 Finding angles from trigonometric ratios

Calculate the value of each of the following expressions using your calculator, where possible, giving your answers correct to 1 decimal place.

1. $\sin^{-1}(0.5)$
2. $\cos^{-1}\left(\frac{2}{3}\right)$
3. $\tan^{-1}(2)$
4. $\sin^{-1}(2)$

Answer

1. $\sin^{-1}(0.5) = 30.0^\circ$

If you obtained the answer $\frac{\pi}{6}$ or 0.5236 (to 4 decimal places), then your calculator is set to work in radians. Make sure that you are working in degrees.

2. $\cos^{-1}\left(\frac{2}{3}\right) = 48.2^\circ$ (to 1 decimal place).

3. $\tan^{-1}(2) = 63.4^\circ$ (to 1 decimal place).

4. The calculation $\sin^{-1}(2)$ is not possible, and your calculator will give a 'Math Error'. There is no angle whose sine is 2, because the hypotenuse is always the largest side of a right-angled triangle, and hence the maximum value the sine of an angle can be is 1.

In part (1) of the activity above, you used your calculator to find an angle whose sine is 0.5. This is not the only angle whose sine is 0.5, but you can use this angle to find the other angles. Similar remarks apply to parts (2) and (3).

9 Radians on your calculator

Your calculator can be set to calculate trigonometric functions using the radian measure for angles, instead of degrees, by using the key sequence

SHIFT **MODE** (SETUP) **4** (Rad).

When in this mode, the display indicator **R** is shown.

Activity 18 Radians on your calculator

In this activity, the angles are measured in radians. Find the values of the following expressions, giving your answers correct to 3 significant figures.

1. $\sin 1$
2. $\cos \frac{\pi}{3}$
3. $\tan^{-1}(1)$

Answer

Remember to set your calculator to work in radians before entering these calculations.

1. $\sin 1 = 0.841$ (to 3 significant figures).








2. $\cos \frac{\pi}{3} = \frac{1}{2} = 0.5$





Remember: π can be input to the calculator using **SHIFT** **x10^x** (**π**).

3. $\tan^{-1}(1) = \frac{1}{4}\pi$ or 0.785 (to 3 significant figures).

Notice from the final example in this activity that where an answer is a simple (possibly fractional) multiple of π , the answer is displayed in terms of π rather than as a decimal number.

10 Logarithms on your calculator

Logarithms to base 10 of numbers can be found using the  key. For example, $\log_{10} 100$ can be calculated using the key sequence     . Note that as with the trigonometric functions, the  key automatically opens a bracket that must be closed if you are using the calculated logarithm as part of a longer calculation.


The second function of the  key (10^x), accessed using   (10^x), can be used as an alternative to  when calculating powers of 10.

Activity 19 Calculating logarithms

Use your calculator to find the values of the following.






$\log_{10} 10$, $\log_{10} 1000$, $\log_{10} (1 \text{ billion})$, $\log_{10} 0.001$



Answer

All the calculations are logarithms to base 10, so we use the  key.

$\log_{10} 10 = 1$, $\log_{10} 1000 = 3$, $\log_{10} (1 \text{ billion})$
 $= \log_{10}(10^9) = 9$, $\log_{10} 0.001 = -3$.

11 Natural logarithms and powers of e on your calculator

Natural logarithms, for example $\ln 2$, can be evaluated on your calculator using the  key. The second function of this key (  (e^x)) permits the calculation of powers of e . Note that an approximate value for e itself can be obtained using the key sequence   (e).

Remember that \log_e means the same as \ln . Some calculators have a  key instead of .

Activity 20 Calculating natural logarithms and powers of e

Calculate the value of each of the following using your calculator, giving each answer to 3 significant figures.

1. $\ln 2$
2. $\ln 10$
3. $\ln 1000$
4. $\ln 3 + 2.47$
5. e^3

Answer

1. $\ln 2 = 0.693$ (to 3 significant figures).

2. $\ln 10 = 2.30$ (to 3 significant figures).

3. $\ln 1000 = 6.91$ (to 3 significant figures).

Notice that this is about three times the answer to part (2). In fact, the exact value of $\ln 1000$ is precisely three times the exact value of $\ln 10$. This is because $1000 = 10^3$, and for any base of logarithm, $\log(x^n) = n \log x$. This is an important result for logarithms. In this case we have $\log 10^3 = 3 \log 10$.

4. $\ln 3 + 2.47 = 3.57$ (to 3 significant figures).

To calculate this answer correctly, you need to remember to close the bracket after the 3 on your calculator display.

5. $e^3 = 20.1$ (to 3 significant figures).

12 Calculator reference guide



Calculator modes

General modes

The calculator can operate in several different modes:

- COMP, which is used for general calculations
- STAT, which is used for statistical calculations
- TABLE, which is used for generating tables of numbers.




COMP is short for 'computation', and STAT is short for 'statistics'.

Comp mode is selected by using the key sequence   (COMP).




Mathematics modes

There are two different ways in which mathematics can be input to and displayed on the calculator:

- Math mode, in which fractions are entered and displayed in their proper mathematical form – for example, $\frac{2}{3}$ – and some irrational numbers are displayed as surds (such as $\sqrt{2}$) or multiples of π (such as $\frac{3}{2}\pi$).




Math mode is selected by using the key sequence   (SETUP)  (MthIO).

- Linear mode, in which fractions such as $\frac{2}{3}$ are entered and displayed using a linear notation – for example, 2 $\frac{2}{3}$ 3 – and all irrational numbers (such as $\sqrt{2}$ and $\frac{3}{2}\pi$) are displayed as decimal approximations.

Linear mode is selected by using the key sequence   (SETUP)  (LineIO).

Put simply, an irrational number is one that cannot be expressed as a simple fraction.

You know that you are in Math mode if the word Math is shown near the right-hand side of the top of the calculator display. If this is not shown, you are using Linear mode.

In Math mode, you can force an answer to be displayed as a decimal using   , or you can toggle between the mathematical and decimal outputs using .

Fraction display modes

It is possible to set the calculator so that answers that are top-heavy fractions (such as $\frac{5}{3}$) are always displayed as mixed numbers (such as $1\frac{2}{3}$).

- To set the calculator to display as mixed numbers, use the key sequence

  (SETUP)   (ab/c).

- To set the calculator to display as top-heavy fractions, use the key sequence

  (SETUP)   (d/c).

Decimal display modes

The calculator can be set to display decimal numbers in various different ways:




- Normal 1 (Norm 1) mode uses scientific notation for any number less than 0.01 but greater than -0.01, and otherwise displays answers to however decimal places they have, subject to the maximum that will fit on the display. This mode is entered using


  (SETUP)  (Norm) .

- Normal 2 (Norm 2) mode uses scientific notation for any number less than 0.000000001 but greater than -0.000000001, but otherwise displays answers to however many decimal places they have, subject to the maximum that will fit on the

display. This mode is entered using   (SETUP)  (Norm) .


- Scientific notation mode (Sci) displays all decimal numbers in scientific notation using a specified number of significant figures. This mode is entered using

  (SETUP)  (Sci) followed by the number of significant figures

required, for example . When your calculator is set in this mode, the display indicator SCI is shown.










- Fixed decimal place mode (Fix) displays all decimal numbers to a given number of decimal places (unless scientific notation is needed to fit the result on the display).

This mode is entered using   (SETUP)  (Fix) followed by the number




of decimal places required, for example . When your calculator is set in this mode, the display indicator FIX is shown.

12.1 Display indicators

These are symbols shown on the calculator display to indicate its current state of operation.

Symbol on display	Meaning
S	The  key has been pressed.
A	The  key has been pressed.
M	A value is stored in the 'M' memory.
STO	The STORE key (  (STO)) has been pressed.
RCL	The RECALL () key has been pressed.
D	The calculator is set to measure angles in degrees.
R	The calculator is set to measure angles in radians.
G	The calculator is set to measure angles in gradians.
FIX	The calculator is set to display answers to a fixed number of decimal places.
SCI	The calculator is set to display answers in scientific notation with a fixed number of significant figures.
Math	The calculator is set to use Math mode for input and display.
STAT	The calculator is in statistics mode.
	There is more information available than can be displayed, and this can be accessed using the up/down cursor keys.
	The line displayed is longer than can fit on the display. Other parts of the line can be displayed by scrolling using the left/right cursor keys:  and  .

12.2 Common operations

To	Key sequence
Turn on	
Turn off	  (OFF)
Note that the calculator will automatically turn off if not used for about 6 minutes.	

Adjust the display contrast

SHIFT **MODE** (SETUP)
 (▼) **5** (◀CONT▶) then use (◀) and
 (▶) to adjust, and press **AC** when finished.

Restore the factory settings

SHIFT **9** (CLR) **1** (Setup)
= (Yes) **AC**

Clear the contents of all memories

SHIFT **9** (CLR) **2** (Memory)
= (Yes) **AC**

Restore the default settings and clear all memories

SHIFT **9** (CLR) **3** (All) **=** (Yes) **AC**

Cancel a calculation, or exit menus

AC

Obtain an answer

=

Obtain a decimal answer in Math mode

SHIFT **=**

Toggle between exact and decimal answers in Math mode

S↔D

Toggle between displaying fractions as improper fractions or mixed numbers in Math mode

SHIFT **S↔D** $(a \frac{b}{c} \leftrightarrow \frac{a}{c} + \frac{b}{c})$

Use the result of the previous calculation...

Ans

... e.g. to find 42 minus the previous result

4 **2** **-** **Ans** **=**

Store a value in 'M' memory

SHIFT **RCL** (STO) **M+** (M)

Clear a value stored in the M memory

0 **SHIFT** **RCL** (STO) **M+** (M)

Add a value to that in the 'M' memory

M+

Subtract a value from that in the 'M' memory

SHIFT **M+** (M-)

Display the value stored in the 'M' memory

RCL **M+** (M)

Use the value in the 'M' memory in a calculation...

ALPHA **M+** (M)

... e.g. to find 42 minus the value in the 'M' memory

4 **2** **-** **ALPHA** **M+** (M) **=**

Set angles to be measured in degrees

SHIFT **MODE** (SETUP) **3** (Deg)

Set angles to be measured in radians

SHIFT **MODE** (SETUP) **4** (Rad)

Set answers to be displayed to 3 decimal places (To use a different number of decimal

places, replace **3** with that number)

SHIFT **MODE** (SETUP) **6** (Fix) **3**

Set answers to be displayed in scientific notation with 3 significant figures (To use a different number of significant figures, replace

3 with that number)

SHIFT **MODE** (SETUP) **7** (Sci) **3**

Cancel any display rounding settings

SHIFT **MODE** (SETUP) **8** (Norm) **2**

The A, B, C, D, X, Y memories are used similarly to the M memory, except that these have no 'add to' and 'subtract from' functions.

12.3 Entering mathematics

To enter	Key sequence
-2	(-) 2 or - 2
3^2	3 x^2 or 3 x^{\square} 2
4^3	4 x^3 or 4 x^{\square} 3
5^4	5 x^{\square} 4
$\sqrt{3}$	$\sqrt{\square}$ 3
$\sqrt[3]{4}$	SHIFT $\sqrt{\square}$ ($\sqrt[3]{\square}$) 4
$\sqrt[4]{5}$	SHIFT x^{\square} ($\sqrt[4]{\square}$) 4 \blacktriangleright 5
$\frac{2}{3}$	In Math mode: $\frac{\square}{\square}$ 2 \blacktriangledown 3
	In Linear mode: 2 $\frac{\square}{\square}$ 3
$1\frac{2}{3}$	In Math mode: SHIFT $\frac{\square}{\square}$ ($\frac{\square}{\square}$) 1 \blacktriangleright 2 \blacktriangledown 3
	In Linear mode: 1 $\frac{\square}{\square}$ 2 $\frac{\square}{\square}$ 3
2×10^4	2 $\times 10^{\square}$ 4

π	SHIFT $\times 10^x$ (π)
e	ALPHA $\times 10^x$ (e)
$\sin 30$	sin 3 0)
$\cos 60$	cos 6 0)
$\tan 45$	tan 4 5)
$\sin^{-1}(0.5)$	SHIFT sin (\sin^{-1}) 0 . 5)
$\log_{10} 5$	log 5)
$\ln 2$	ln 2)
$e^{1.4}$	SHIFT ln (e^x) 1 . 4

π and e are mathematical constants.

When using trigonometric functions, ensure that your calculator is set to use the correct units: degrees or radians.

$\cos^{-1}(0.5)$ and $\tan^{-1}(0.5)$ are calculated in a similar way to $\sin^{-1}(0.5)$.

Conclusion

This free course provided an introduction to studying Mathematics and Statistics. It took you through a series of exercises designed to develop your approach to study and learning at a distance and helped to improve your confidence as an independent learner.

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