Graphics calculator instructions

Contents:

In this course it is assumed that you have a **graphics calculator**. If you learn how to operate your calculator successfully, you should experience little difficulty with future arithmetic calculations.

There are many different brands (and types) of calculators. Different calculators do not have exactly the same keys. It is therefore important that you have an instruction booklet for your calculator, and use it whenever you need to.

However, to help get you started, we have included here some basic instructions for the **Texas Instruments TI-84 Plus** and the **Casio fx-9860G** calculators. Note that instructions given may need to be modified slightly for other models.

GETTING STARTED

Texas Instruments TI-84 Plus

The screen which appears when the calculator is turned on is the **home screen**. This is where most basic calculations are performed.

You can return to this screen from any menu by pressing [2nd] [MODE].

When you are on this screen you can type in an expression and evaluate it using the [ENTER] key.

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Press [MENU] to access the Main Menu, and select **RUN·MAT**.

This is where most of the basic calculations are performed.

When you are on this screen you can type in an expression and evaluate it using the [EXE] key.

A BASIC CALCULATIONS

Most modern calculators have the rules for **Order of Operations** built into them. This order is sometimes referred to as BEDMAS.

This section explains how to enter different types of numbers such as negative numbers and fractions, and how to perform calculations using grouping symbols (brackets), powers, and square roots. It also explains how to round off using your calculator.

NEGATIVE NUMBERS

To enter negative numbers we use the **sign change** key. On both the **TI-84 Plus** and **Casio** this looks like [(−)]. Simply press the sign change key and then type in the number.

For example, to enter -7, press [(−)] 7.

FRACTIONS

On most scientific calculators and also the **Casio** graphics calculator there is a special key for entering fractions. No such key exists for the **TI-84 Plus**, so we use a different method.

Texas Instruments TI-84 Plus

To enter common fractions, we enter the fraction as a division.

For example, we enter $\frac{3}{4}$ by typing 3 [÷] 4. If the fraction is part of a larger calculation, it is generally wise to place this division in brackets, i.e., [(] 3 [÷] 4 [)].

To enter mixed numbers, either convert the mixed number to an improper fraction and enter as a common fraction *or* enter the fraction as a sum.

For example, we can enter $2\frac{3}{4}$ as [(] 11 [÷] 4 [)] *or* [(] 2 [+] 3 [÷] 4 [)].

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To enter fractions we use the **fraction** key [a b/c].

For example, we enter $\frac{3}{4}$ by typing 3 [a b/c] 4 and $2\frac{3}{4}$ by typing 2 [a b/c] 3 [a b/c] 4.

Press [SHIFT] [a b/c] $(a\frac{b}{c} \leftrightarrow \frac{d}{c})$ to convert between mixed numbers and improper fractions.

SIMPLIFYING FRACTIONS & RATIOS

Graphics calculators can *sometimes* be used to express fractions and ratios in simplest form.

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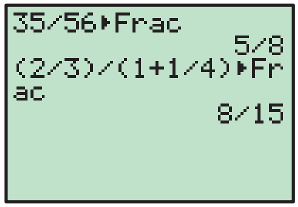

To express the fraction $\frac{35}{56}$ in simplest form, press 35 ÷ 56 MATH **1** ENTER. The result is $\frac{5}{8}$.

To express the ratio $\frac{2}{3} : 1\frac{1}{4}$ in simplest form, press (2 ÷ 3) ÷ (1 + 1 ÷ 4) MATH **1** ENTER.

The ratio is 8 : 15.

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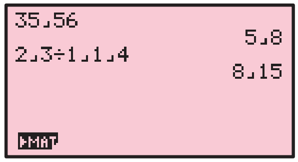

To express the fraction $\frac{35}{56}$ in simplest form, press 35 a b/c 56 EXE. The result is $\frac{5}{8}$.

To express the ratio $\frac{2}{3} : 1\frac{1}{4}$ in simplest form, press 2 a b/c 3 ÷ 1 a b/c 1 a b/c 4 EXE. The ratio is 8 : 15.

ENTERING TIMES

In questions involving time, it is often necessary to be able to express time in terms of hours, minutes and seconds.

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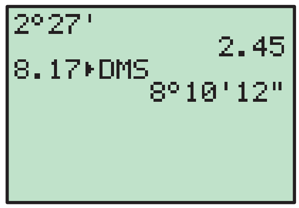
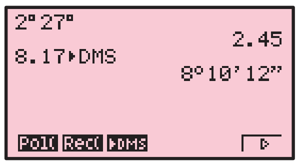


To enter 2 hours 27 minutes, press 2 2nd APPS **(ANGLE) 1:°** 27 2nd APPS **2:′**. This is equivalent to 2.45 hours.

To express 8.17 hours in terms of hours, minutes and seconds, press 8.17 2nd APPS **4:▶DMS** ENTER.
This is equivalent to 8 hours, 10 minutes and 12 seconds.

Casio fx-9860g



To enter 2 hours 27 minutes, press OPTN F6 F5 **(ANGL)** 2 F4 **(°′″)** 27 F4 **(°′″)** EXE. This is equivalent to 2.45 hours.

To express 8.17 hours in terms of hours, minutes and seconds, press 8.17 OPTN F6 F5 **(ANGL)** F6 F3 **(▶DMS)** EXE. This is equivalent to 8 hours, 10 minutes and 12 seconds.

B BASIC FUNCTIONS

GROUPING SYMBOLS (BRACKETS)

Both the **TI-84 Plus** and **Casio** have bracket keys that look like (and).

Brackets are regularly used in mathematics to indicate an expression which needs to be evaluated before other operations are carried out.

For example, to enter $2\times(4+1)$ we type 2 [×] [(] 4 [+] 1 [)].

We also use brackets to make sure the calculator understands the expression we are typing in.

For example, to enter $\frac{2}{4+1}$ we type 2 [÷] [(] 4 [+] 1 [)]. If we typed 2 [÷] 4 [+] 1 the calculator would think we meant $\frac{2}{4}+1$.

In general, it is a good idea to place brackets around any complicated expressions which need to be evaluated separately.

POWER KEYS

Both the **TI-84 Plus** and **Casio** also have power keys that look like [∧]. We type the base first, press the power key, then enter the index or exponent.

For example, to enter 25^3 we type 25 [∧] 3.

Note that there are special keys which allow us to quickly evaluate squares.

Numbers can be squared on both **TI-84 Plus** and **Casio** using the special key [x^2].

For example, to enter 25^2 we type 25 [x^2].

ROOTS

To enter roots on either calculator we need to use a secondary function (see **Secondary Function and Alpha Keys**).

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The **TI-84 Plus** uses a secondary function key [2nd].

We enter square roots by pressing [2nd] [x^2].

For example, to enter $\sqrt{36}$ we press [2nd] [x^2] 36 [)].

The end bracket is used to tell the calculator we have finished entering terms under the square root sign.

Cube roots are entered by pressing [MATH] **4:** $\sqrt[3]{}$ (.

For example, to enter $\sqrt[3]{8}$ we press [MATH] **4** 8 [)].

Higher roots are entered by pressing [MATH] **5**: $\sqrt[x]{}$.

For example, to enter $\sqrt[4]{81}$ we press 4 [MATH] **5** 81 [)].

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The Casio uses a shift key SHIFT to get to its second functions.

We enter square roots by pressing SHIFT x^2 .

For example, to enter $\sqrt{36}$ we press SHIFT x^2 36.

If there is a more complicated expression under the square root sign you should enter it in brackets.

For example, to enter $\sqrt{18 \div 2}$ we press SHIFT x^2 (18 ÷ 2) .

Cube roots are entered by pressing SHIFT (. For example, to enter $\sqrt[3]{8}$ we press SHIFT (8.

Higher roots are entered by pressing SHIFT ∧ . For example, to enter $\sqrt[4]{81}$ we press 4 SHIFT ∧ 81.

LOGARITHMS

We can perform operations involving logarithms in base 10 using the log button. For other bases the method we use depends on the brand of calculator.

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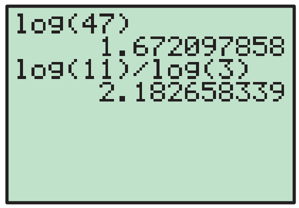
To evaluate $\log(47)$, press log 47) ENTER .

Since $\log_a b = \dfrac{\log b}{\log a}$, we can use the base 10 logarithm to calculate logarithms in other bases.

To evaluate $\log_3 11$, we note that $\log_3 11 = \dfrac{\log 11}{\log 3}$, so we press

log 11) ÷ log 3) ENTER .



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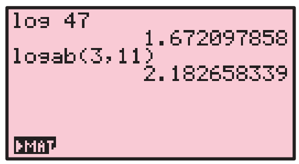
To evaluate $\log(47)$ press log 47 EXE .

To evaluate $\log_3 11$, press SHIFT **4 (CATALOG)**, and select **logab(** . You can use the alpha keys to navigate the catalog, so in this example press → to jump to "L". Press 3 , 11) EXE .



ROUNDING OFF

You can use your calculator to round off answers to a fixed number of decimal places.

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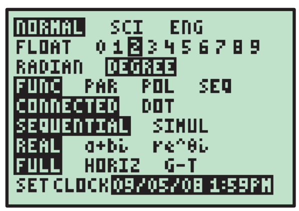
To round to 2 decimal places, press MODE then ▼ to scroll down to Float.

Use the ▶ button to move the cursor over the 2 and press ENTER . Press 2nd MODE to return to the home screen.

If you want to unfix the number of decimal places, press MODE ▼ ENTER to highlight Float.



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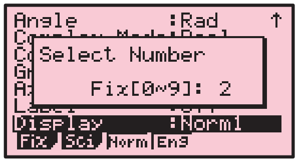

To round to 2 decimal places, select **RUN·MAT** from the Main Menu, and press [SHIFT] [MENU] to enter the setup screen. Scroll down to Display, and press [F1] (**Fix**). Press 2 [EXE] to select the number of decimal places. Press [EXIT] to return to the home screen.

To unfix the number of decimal places, press [SHIFT] [MENU] to return to the setup screen, scroll down to Display, and press [F3] (**Norm**).

INVERSE TRIGONOMETRIC FUNCTIONS

To enter inverse trigonometric functions, you will need to use a secondary function (see **Secondary Function and Alpha Keys**).

Texas Instruments TI-84 Plus

The inverse trigonometric functions $\sin^{-1}$, $\cos^{-1}$ and $\tan^{-1}$ are the secondary functions of [SIN], [COS] and [TAN] respectively. They are accessed by using the secondary function key [2nd].

For example, if $\cos x = \frac{3}{5}$, then $x = \cos^{-1}\left(\frac{3}{5}\right)$.

To calculate this, press [2nd] [COS] 3 [÷] 5 [)] [ENTER].

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The inverse trigonometric functions $\sin^{-1}$, $\cos^{-1}$ and $\tan^{-1}$ are the secondary functions of [sin], [cos] and [tan] respectively. They are accessed by using the secondary function key [SHIFT].

For example, if $\cos x = \frac{3}{5}$, then $x = \cos^{-1}\left(\frac{3}{5}\right)$.

To calculate this, press [SHIFT] [cos] [(] 3 [÷] 5 [)] [EXE].

STANDARD FORM

If a number is too large or too small to be displayed neatly on the screen, it will be expressed in standard form, which is the form $a \times 10^n$ where $1 \leqslant a < 10$ and n is an integer.

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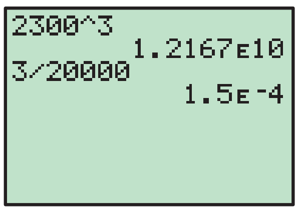
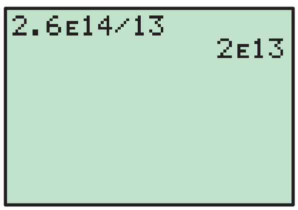


To evaluate 2300^3, press 2300 [^] 3 [ENTER].
The answer displayed is 1.2167E10, which means 1.2167×10^{10}.

To evaluate $\dfrac{3}{20\,000}$, press 3 [÷] 20 000 [ENTER].
The answer displayed is 1.5E−4, which means 1.5×10^{-4}.



You can enter values in standard form using the EE function, which is accessed by pressing [2nd] [,].

For example, to evaluate $\dfrac{2.6 \times 10^{14}}{13}$, press 2.6 [2nd] [,] 14 [÷] 13 [ENTER].
The answer is 2×10^{13}.

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To evaluate 2300^3, press 2300 [^] 3 [EXE].

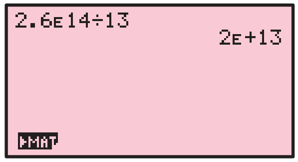
The answer displayed is 1.2167E+10, which means 1.2167×10^{10}.

To evaluate $\frac{3}{20\,000}$, press 3 [÷] 20 000 [EXE].

The answer displayed is 1.5E−04, which means 1.5×10^{-4}.

You can enter values in standard form using the [EXP] key. For example, to evaluate $\frac{2.6 \times 10^{14}}{13}$, press 2.6 [EXP] 14 [÷] 13 [EXE].

The answer is 2×10^{13}.



C SECONDARY FUNCTION AND ALPHA KEYS

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The **secondary function** of each key is displayed in blue above the key. It is accessed by pressing the [2nd] key, followed by the key corresponding to the desired secondary function. For example, to calculate $\sqrt{36}$, press [2nd] [x^2] 36 [)] [ENTER].

The **alpha function** of each key is displayed in green above the key. It is accessed by pressing the [ALPHA] key followed by the key corresponding to the desired letter. The main purpose of the alpha keys is to store values into memory which can be recalled later. Refer to the **Memory** section.

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The **shift function** of each key is displayed in yellow above the key. It is accessed by pressing the [SHIFT] key followed by the key corresponding to the desired shift function.

For example, to calculate $\sqrt{36}$, press [SHIFT] [x^2] 36 [EXE].

The **alpha function** of each key is displayed in red above the key. It is accessed by pressing the [ALPHA] key followed by the key corresponding to the desired letter. The main purpose of the alpha keys is to store values which can be recalled later.

D MEMORY

Utilising the memory features of your calculator allows you to recall calculations you have performed previously. This not only saves time, but also enables you to maintain accuracy in your calculations.

SPECIFIC STORAGE TO MEMORY

Values can be stored into the variable letters A, B, ..., Z using either calculator. Storing a value in memory is useful if you need that value multiple times.

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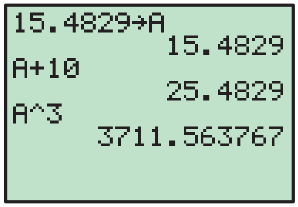
Suppose we wish to store the number 15.4829 for use in a number of calculations. Type in the number then press [STO▶] [ALPHA] [MATH] **(A)** [ENTER].



We can now add 10 to this value by pressing [ALPHA] [MATH] [+] 10 [ENTER], or cube this value by pressing [ALPHA] [MATH] [^] 3 [ENTER].

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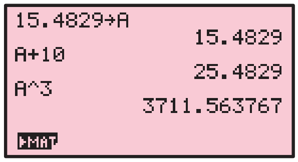
Suppose we wish to store the number 15.4829 for use in a number of calculations. Type in the number then press [→] [ALPHA] [X,θ,T] **(A)** [EXE].

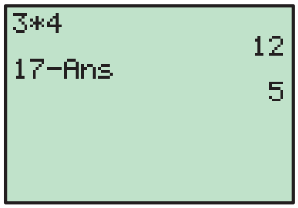


We can now add 10 to this value by pressing [ALPHA] [X,θ,T] [+] 10 [EXE], or cube this value by pressing [ALPHA] [X,θ,T] [^] 3 [EXE].

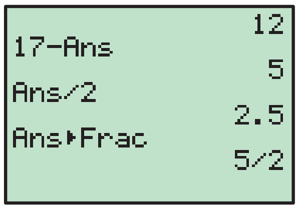
ANS VARIABLE

Texas Instruments TI-84 Plus

The variable **Ans** holds the most recent evaluated expression, and can be used in calculations by pressing [2nd] [(−)].



For example, suppose you evaluate 3×4, and then wish to subtract this from 17. This can be done by pressing 17 [−] [2nd] [(−)] [ENTER].



If you start an expression with an operator such as [+], [−], etc, the previous answer **Ans** is automatically inserted ahead of the operator. For example, the previous answer can be halved simply by pressing [÷] 2 [ENTER].

If you wish to view the answer in fractional form, press [MATH] 1 [ENTER].

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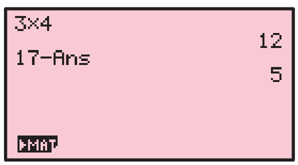
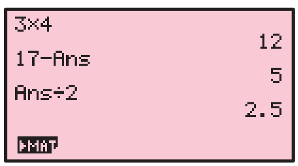
The variable **Ans** holds the most recent evaluated expression, and can be used in calculations by pressing [SHIFT] [(−)]. For example, suppose you evaluate 3×4, and then wish to subtract this from 17. This can be done by pressing 17 [−] [SHIFT] [(−)] [EXE].



If you start an expression with an operator such as [+], [−], etc, the previous answer Ans is automatically inserted ahead of the operator. For example, the previous answer can be halved simply by pressing [÷] 2 [EXE].



If you wish to view the answer in fractional form, press [F↔D].

RECALLING PREVIOUS EXPRESSIONS

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The **ENTRY** function recalls previously evaluated expressions, and is used by pressing 2nd ENTER .

This function is useful if you wish to repeat a calculation with a minor change, or if you have made an error in typing.

Suppose you have evaluated $100 + \sqrt{132}$. If you now want to evaluate $100 + \sqrt{142}$, instead of retyping the command, it can be recalled by pressing 2nd ENTER .

The change can then be made by moving the cursor over the 3 and changing it to a 4, then pressing ENTER .

If you have made an error in your original calculation, and intended to calculate $1500 + \sqrt{132}$, again you can recall the previous command by pressing 2nd ENTER .

Move the cursor to the first 0.

You can insert the digit 5, rather than overwriting the 0, by pressing 2nd DEL 5 ENTER .

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Pressing the left cursor key allows you to edit the most recently evaluated expression, and is useful if you wish to repeat a calculation with a minor change, or if you have made an error in typing.

Suppose you have evaluated $100 + \sqrt{132}$.

If you now want to evaluate $100 + \sqrt{142}$, instead of retyping the command, it can be recalled by pressing the left cursor key.

Move the cursor between the 3 and the 2, then press DEL 4 to remove the 3 and change it to a 4. Press EXE to re-evaluate the expression.

E LISTS

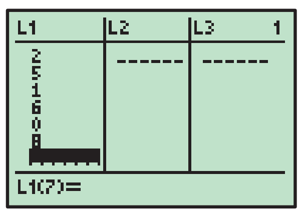
Lists are used for a number of purposes on the calculator. They enable us to enter sets of numbers, and we use them to generate number sequences using algebraic rules.

CREATING A LIST

Texas Instruments TI-84 Plus

Press STAT 1 to take you to the **list editor** screen.

To enter the data $\{2, 5, 1, 6, 0, 8\}$ into **List 1**, start by moving the cursor to the first entry of **L1**. Press 2 ENTER 5 ENTER ...... and so on until all the data is entered.



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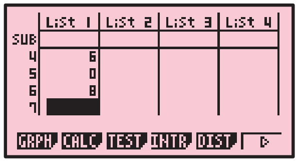
Selecting **STAT** from the Main Menu takes you to the **list editor** screen.



To enter the data {2, 5, 1, 6, 0, 8} into **List 1**, start by moving the cursor to the first entry of **List 1**. Press 2 EXE 5 EXE ...... and so on until all the data is entered.

DELETING LIST DATA

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Pressing STAT **1** takes you to the **list editor** screen.

Move the cursor to the heading of the list you want to delete then press CLEAR ENTER .

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Selecting **STAT** from the Main Menu takes you to the **list editor** screen.

Move the cursor to anywhere on the list you wish to delete, then press F6 **(▷)** F4 **(DEL-A)** F1 **(Yes)**.

REFERENCING LISTS

Texas Instruments TI-84 Plus

Lists can be referenced by using the secondary functions of the keypad numbers 1–6.

For example, suppose you want to add 2 to each element of **List 1** and display the results in **List 2**. To do this, move the cursor to the heading of $\mathbf{L_2}$ and press 2nd 1 ($\mathbf{L_1}$) + 2 ENTER .

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Lists can be referenced using the List function, which is accessed by pressing SHIFT **1**.

For example, if you want to add 2 to each element of **List 1** and display the results in **List 2**, move the cursor to the heading of **List 2** and press SHIFT 1 **(List)** 1 + 2 EXE .

For Casio models without the List function, you can do this by pressing OPTN F1 **(LIST)** F1 **(List)** 1 + 2 EXE .

NUMBER SEQUENCES

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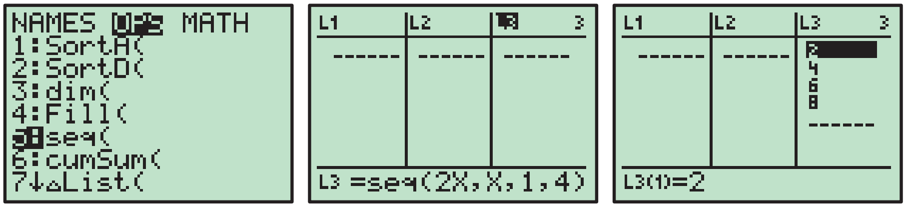
You can create a sequence of numbers defined by a certain rule using the *seq* command.

This command is accessed by pressing 2nd STAT ► to enter the **OPS** section of the List menu, then selecting **5:seq**.

For example, to store the sequence of even numbers from 2 to 8 in **List 3**, move the cursor to the heading of $\mathbf{L_3}$, then press 2nd STAT ► 5 to enter the *seq* command, followed by 2 X,T,θ,n , X,T,θ,n , 1 , 4) ENTER .

This evaluates $2x$ for every value of x from 1 to 4.



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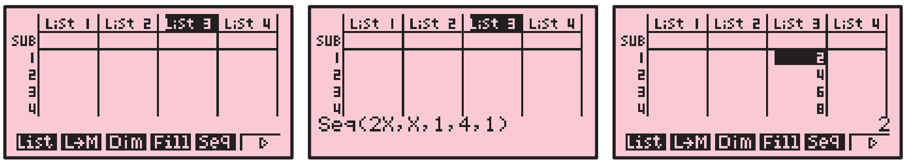
You can create a sequence of numbers defined by a certain rule using the *seq* command.

This command is accessed by pressing OPTN F1 **(LIST)** F5 **(Seq)**.

For example, to store the sequence of even numbers from 2 to 8 in **List 3**, move the cursor to the heading of **List 3**, then press OPTN F1 F5 to enter a sequence, followed by 2 X,θ,T , X,θ,T , 1 , 4 , 1) EXE .

This evaluates $2x$ for every value of x from 1 to 4 with an increment of 1.



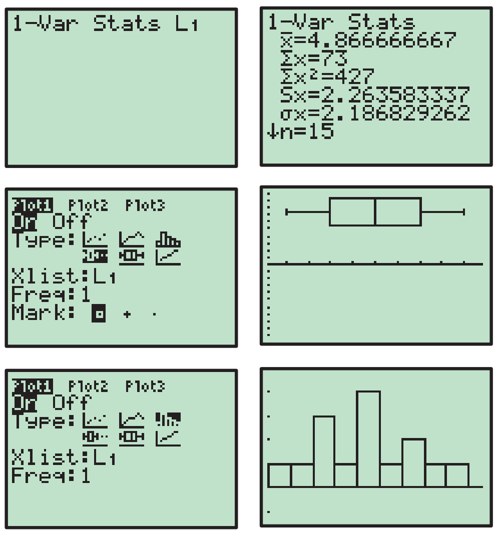
F STATISTICAL GRAPHS

Your graphics calculator is a useful tool for analysing data and creating statistical graphs.

In this section we produce descriptive statistics and graphs for the data set: 5 2 3 3 6 4 5 3 7 5 7 1 8 9 5.

Texas Instruments TI-84 Plus

Enter the data set into **List 1** using the instructions on page 19. To obtain descriptive statistics of the data set, press STAT ▶ **1:1-Var Stats** 2nd **1 (L₁)** ENTER .

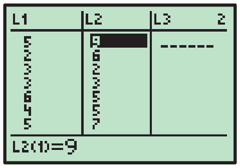


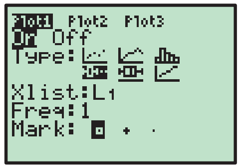
To obtain a boxplot of the data, press 2nd Y= **(STAT PLOT) 1** and set up **Statplot1** as shown. Press ZOOM **9:ZoomStat** to graph the boxplot with an appropriate window.

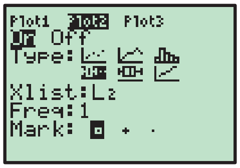
To obtain a vertical bar chart of the data, press 2nd Y= **1**, and change the type of graph to a vertical bar chart as shown. Press ZOOM **9:ZoomStat** to draw the bar chart. Press WINDOW and set the **Xscl** to 1, then GRAPH to redraw the bar chart.

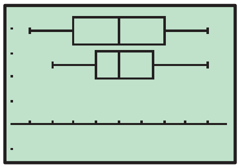
We will now enter a second set of data, and compare it to the first.

Enter the data set 9 6 2 3 5 5 7 5 6 7 6 3 4 4 5 8 4 into **List 2**, press 2nd Y= **1**, and change the type of graph back to a boxplot as shown. Move the cursor to the top of the screen and select **Plot2**. Set up **Statplot2** in the same manner, except set the **XList** to **L2**. Press ZOOM **9:ZoomStat** to draw the side-by-side boxplots.









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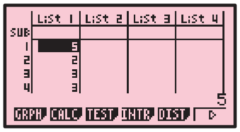
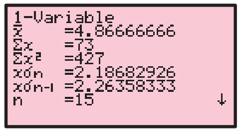
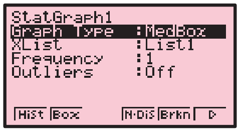
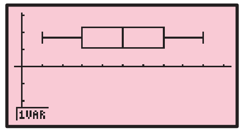
Enter the data into **List 1** using the instructions on page **19**. To obtain the descriptive statistics, press F6 (▷) until the **GRPH** icon is in the bottom left corner of the screen, then press F2 **(CALC)** F1 **(1 VAR)**.



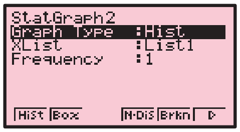


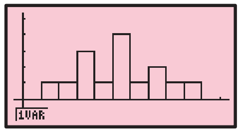
To obtain a boxplot of the data, press EXIT EXIT F1 **(GRPH)** F6 **(SET)**, and set up **StatGraph 1** as shown. Press EXIT F1 **(GPH1)** to draw the boxplot.





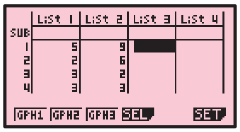
To obtain a vertical bar chart of the data, press EXIT F6 **(SET)** F2 **(GPH2)**, and set up **StatGraph 2** as shown. Press EXIT F2 **(GPH2)** to draw the bar chart (set Start to 0, and Width to 1).

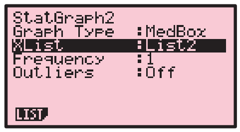


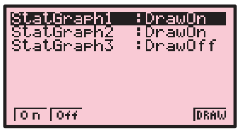


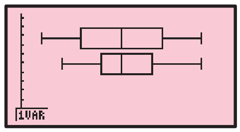
We will now enter a second set of data, and compare it to the first.

Enter the data set 9 6 2 3 5 5 7 5 6 7 6 3 4 4 5 8 4 into **List 2**, then press F6 **(SET)** F2 **(GPH2)** and set up **StatGraph 2** to draw a boxplot of this data set as shown. Press EXIT F4 **(SEL)**, and turn on both **StatGraph 1** and **StatGraph 2**. Press F6 **(DRAW)** to draw the side-by-side boxplots.







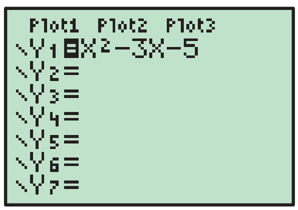


G WORKING WITH FUNCTIONS

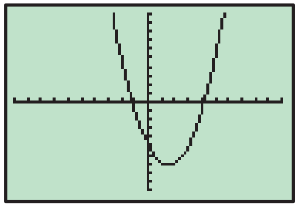
GRAPHING FUNCTIONS

Texas Instruments TI-84 Plus

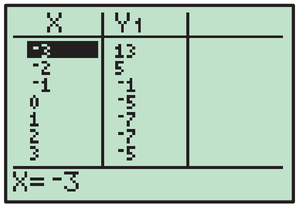
Pressing Y= selects the **Y=** editor, where you can store functions to graph. Delete any unwanted functions by scrolling down to the function and pressing CLEAR .



To graph the function $y = x^2 - 3x - 5$, move the cursor to **Y1**, and press [X,T,θ,n] [x^2] [−] 3 [X,T,θ,n] [−] 5 [ENTER]. This stores the function into **Y1**. Press [GRAPH] to draw a graph of the function.



To view a table of values for the function, press [2nd] [GRAPH] **(TABLE)**. The starting point and interval of the table values can be adjusted by pressing [2nd] [WINDOW] **(TBLSET)**.



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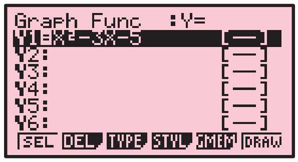
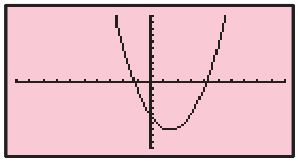
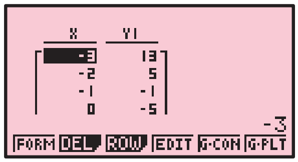
Selecting **GRAPH** from the Main Menu takes you to the Graph Function screen, where you can store functions to graph. Delete any unwanted functions by scrolling down to the function and pressing [DEL] [F1] **(Yes)**.



To graph the function $y = x^2 - 3x - 5$, move the cursor to **Y1** and press [X,θ,T] [x^2] [−] 3 [X,θ,T] [−] 5 [EXE]. This stores the function into **Y1**. Press [F6] **(DRAW)** to draw a graph of the function.



To view a table of values for the function, press [MENU] and select **TABLE**. The function is stored in **Y1**, but not selected. Press [F1] **(SEL)** to select the function, and [F6] **(TABL)** to view the table. You can adjust the table settings by pressing [EXIT] and then [F5] **(SET)** from the Table Function screen.



GRAPHING ABSOLUTE VALUE FUNCTIONS

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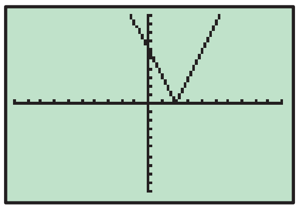
You can perform operations involving absolute values by pressing [MATH] [▶], which brings up the **NUM** menu, followed by **1: abs (** .

To graph the absolute value function $y = |3x - 6|$, press [Y=], move the cursor to $\mathbf{Y}_1$, then press [MATH] [▶] **1** 3 [X,T,θ,n] [−] 6 [)] [GRAPH].



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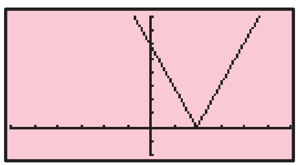
To graph the absolute value function $y = |3x - 6|$, select GRAPH from the Main Menu, move the cursor to **Y1** and press [OPTN] [F5] **(NUM)** [F1] **(Abs)** [(] 3 [X,θ,T] [−] 6 [)] [EXE] [F6] **(DRAW)**.



FINDING POINTS OF INTERSECTION

It is often useful to find the points of intersection of two graphs, for instance, when you are trying to solve simultaneous equations.

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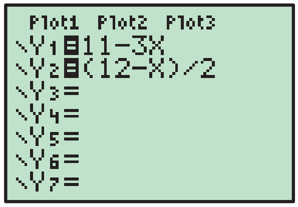
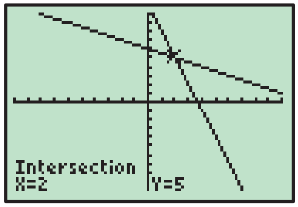


We can solve $y = 11 - 3x$ and $y = \frac{12-x}{2}$ simultaneously by finding the point of intersection of these two lines.

Press [Y=], then store $11 - 3x$ into **Y1** and $\frac{12-x}{2}$ into **Y2**. Press [GRAPH] to draw a graph of the functions.



To find their point of intersection, press [2nd] [TRACE] **(CALC) 5**, which selects **5:intersect**. Press [ENTER] twice to specify the functions **Y1** and **Y2** as the functions you want to find the intersection of, then use the arrow keys to move the cursor close to the point of intersection and press [ENTER] once more.

The solution $x = 2$, $y = 5$ is given.

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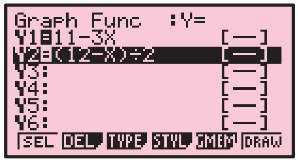
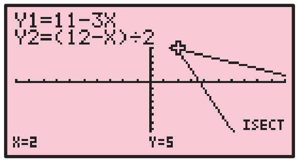


We can solve $y = 11 - 3x$ and $y = \frac{12-x}{2}$ simultaneously by finding the point of intersection of these two lines. Select **GRAPH** from the Main Menu, then store $11 - 3x$ into **Y1** and $\frac{12-x}{2}$ into **Y2**. Press [F6] **(DRAW)** to draw a graph of the functions.



To find their point of intersection, press [F5] **(G-Solv)** [F5] **(ISCT)**. The solution $x = 2$, $y = 5$ is given.

Note: If there is more than one point of intersection, the remaining points of intersection can be found by pressing [▶].

SOLVING $f(x) = 0$

In the special case when you wish to solve an equation of the form $f(x) = 0$, this can be done by graphing $y = f(x)$ and then finding when this graph cuts the x-axis.

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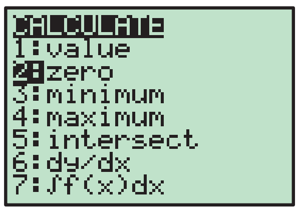
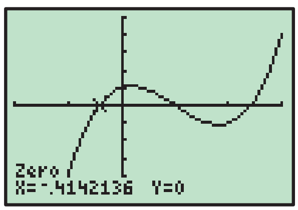


To solve $x^3 - 3x^2 + x + 1 = 0$, press [Y=] and store $x^3 - 3x^2 + x + 1$ into **Y1**. Press [GRAPH] to draw the graph.



To find where this function first cuts the x-axis, press [2nd] [TRACE] **(CALC) 2**, which selects **2:zero**. Move the cursor to the left of the first zero and press [ENTER], then move the cursor to the right of the first zero and press [ENTER]. Finally, move the cursor close to the first zero and press [ENTER] once more. The solution $x \approx -0.414$ is given.

Repeat this process to find the remaining solutions $x = 1$ and $x \approx 2.414$.

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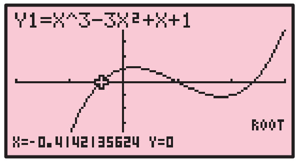
To solve $x^3 - 3x^2 + x + 1 = 0$, select **GRAPH** from the Main Menu and store $x^3 - 3x^2 + x + 1$ into **Y1**. Press F6 **(DRAW)** to draw the graph.



To find where this function cuts the x-axis, press F5 **(G-Solv)** F1 **(ROOT)**. The first solution $x \approx -0.414$ is given.

Press ▶ to find the remaining solutions $x = 1$ and $x \approx 2.414$.

TURNING POINTS

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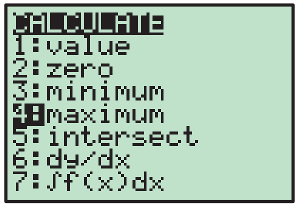
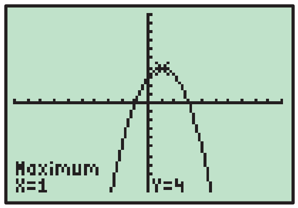
To find the turning point (vertex) of $y = -x^2 + 2x + 3$, press Y= and store $-x^2 + 2x + 3$ into **Y**1. Press GRAPH to draw the graph.



From the graph, it is clear that the vertex is a maximum, so press 2nd TRACE **(CALC) 4** to select **4:maximum**.



Move the cursor to the left of the vertex and press ENTER, then move the cursor to the right of the vertex and press ENTER. Finally, move the cursor close to the vertex and press ENTER once more. The vertex is (1, 4).

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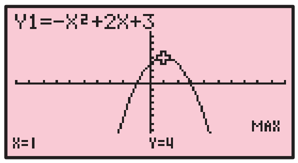
To find the turning point (vertex) of $y = -x^2 + 2x + 3$, select **GRAPH** from the Main Menu and store $-x^2 + 2x + 3$ into **Y1**. Press F6 **(DRAW)** to draw the graph.



From the graph, it is clear that the vertex is a maximum, so to find the vertex press F5 **(G-Solv)** F2 **(MAX)**.

The vertex is (1, 4).

ADJUSTING THE VIEWING WINDOW

When graphing functions it is important that you are able to view all the important features of the graph. As a general rule it is best to start with a large viewing window to make sure all the features of the graph are visible. You can then make the window smaller if necessary.

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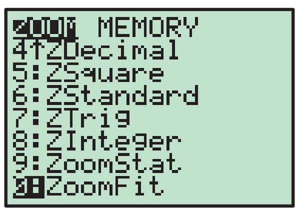
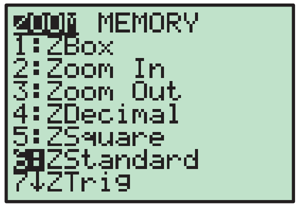
Some useful commands for adjusting the viewing window include:



ZOOM **0:ZoomFit** : This command scales the y-axis to fit the minimum and maximum values of the displayed graph within the current x-axis range.

ZOOM **6:ZStandard** : This command returns the viewing window to the default setting of $-10 \leqslant x \leqslant 10$, $-10 \leqslant y \leqslant 10$.



If neither of these commands are helpful, the viewing window can be adjusted manually by pressing WINDOW and setting the minimum and maximum values for the x and y axes.

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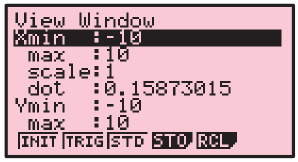
The viewing window can be adjusted by pressing SHIFT F3 **(V-Window)**. You can manually set the minimum and maximum values of the x and y axes, or press F3 **(STD)** to obtain the standard viewing window $-10 \leqslant x \leqslant 10$, $-10 \leqslant y \leqslant 10$.



H TWO VARIABLE ANALYSIS

LINE OF BEST FIT

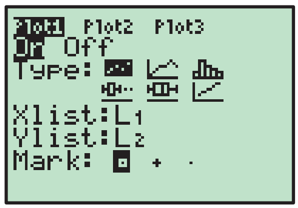
We can use our graphics calculator to find the line of best fit connecting two variables. We can also find the values of Pearson's correlation coefficient r and the coefficient of determination r^2, which measure the strength of the linear correlation between the two variables.

We will examine the relationship between the variables x and y for the data:

x	1	2	3	4	5	6	7
y	5	8	10	13	16	18	20

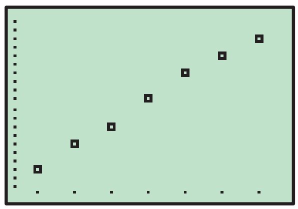
Texas Instruments TI-84 Plus

Enter the x values into **List 1** and the y values into **List 2** using the instructions given on page **19**.



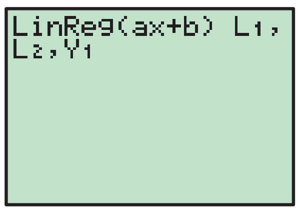
To produce a scatter diagram of the data, press 2nd Y= **(STAT PLOT) 1**, and set up **Statplot 1** as shown.

Press ZOOM **9 : ZoomStat** to draw the scatter diagram.



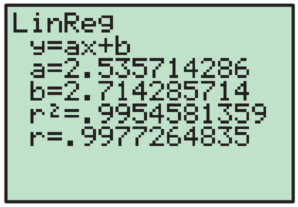
We will now find the line of best fit. Press STAT ▶ **4:LinReg(ax+b)** to select the linear regression option from the CALC menu.

Press 2nd **1 (L_1)** , 2nd **2 (L_2)** , VARS ▶ **1 1 (Y_1)**. This specifies the lists L_1 and L_2 as the lists which hold the data, and the line of best fit will be pasted into the function Y_1. Press ENTER to view the results.



The line of best fit is given as $y \approx 2.54x + 2.71$. If the r and r^2 values are not shown, you need to turn on the Diagnostic by pressing 2nd **0 (CATALOG)** and selecting **DiagnosticOn**.

Press GRAPH to view the line of best fit.



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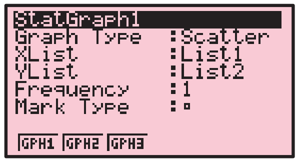
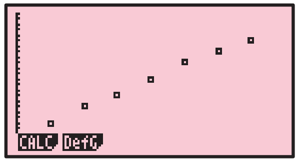
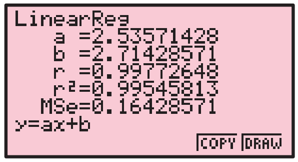
Enter the x values into **List 1** and the y values into **List 2** using the instructions given on page **19**.



To produce a scatter diagram for the data, press F1 (**GRPH**) F6 (**SET**), and set up **StatGraph 1** as shown. Press EXIT F1 (**GPH 1**) to draw the scatter diagram.

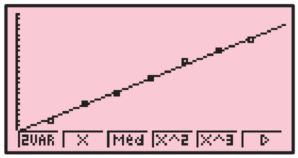


To find the line of best fit, press F1 (**CALC**) F2 (**X**).



We can see that the line of best fit is given as $y \approx 2.54x + 2.71$, and we can view the r and r^2 values.

Press F6 (**DRAW**) to view the line of best fit.

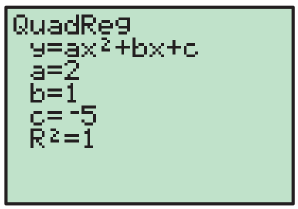


QUADRATIC AND CUBIC REGRESSION

You can use quadratic or cubic regression to find the formula for the general term of a quadratic or cubic sequence.

Texas Instruments TI-84 Plus

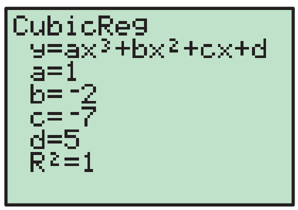
To find the general term for the **quadratic sequence** $-2, 5, 16, 31, 50, ...,$ we first notice that we have been given 5 members of the sequence. We therefore enter the numbers 1 to 5 into **L1**, and the members of the sequence into **L2**.



Press STAT ▶ **5: QuadReg**, then 2nd 1 ($\mathbf{L_1}$) **,** 2nd 2 ($\mathbf{L_2}$) ENTER .

The result is $a = 2$, $b = 1$, $c = -5$, which means the general term for the sequence is $u_n = 2n^2 + n - 5$.

To find the general term for the **cubic sequence** $-3, -9, -7, 9, 45, ...,$ we enter the numbers 1 to 5 into **L1** and the members of the sequence into **L2**.

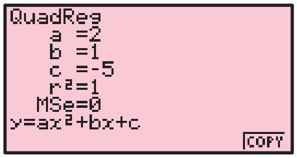


Press STAT ▶ **6: CubicReg**, then 2nd 1 ($\mathbf{L_1}$) **,** 2nd 2 ($\mathbf{L_2}$) ENTER .

The result is $a = 1$, $b = -2$, $c = -7$, $d = 5$, which means the general term for the sequence is $u_n = n^3 - 2n^2 - 7n + 5$.

Casio fx-9860G

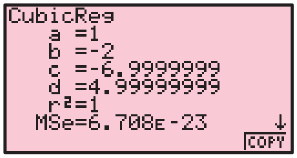
To find the general term for the **quadratic sequence** $-2, 5, 16, 31, 50, ...$, we first notice that we have been given 5 members of the sequence. Enter the numbers 1 to 5 into **List 1**, and the members of the sequence into **List 2**.



Press [F2] **(CALC)** [F3] **(REG)** [F3] **(X^2)**.

The result is $a=2$, $b=1$, $c=-5$, which means the general term for the sequence is $u_n = 2n^2 + n - 5$.

To find the general term for the **cubic sequence** $-3, -9, -7, 9, 45$, we enter the numbers 1 to 5 into **List 1** and the members of the sequence into **List 2**.



Press [F2] **(CALC)** [F3] **(REG)** [F4] **(X^3)**.

The result is $a=1$, $b=-2$, $c=-7$, $d=5$ (the calculator may not always give the result exactly as is the case with c and d in this example). Therefore the general term for the sequence is $u_n = n^3 - 2n^2 - 7n + 5$.

EXPONENTIAL REGRESSION

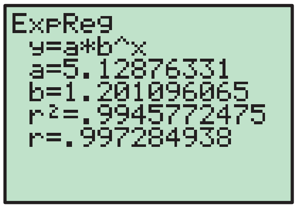
When we have data for two variables x and y, we can use exponential regression to find the exponential model of the form $y = a \times b^x$ which best fits the data.

We will examine the exponential relationship between x and y for the data:

x	2	4	7	9	12
y	7	11	20	26	45

Texas Instruments TI-84 Plus

Enter the x values into **L1** and the y values into **L2**.



Press [STAT] [▶] **0: ExpReg**, then [2nd] 1 **(L**$_1$**)** [,] [2nd] 2 **(L**$_2$**)** [ENTER] .

So, the exponential model which best fits the data is $y \approx 5.13 \times 1.20^x$.

POWER REGRESSION

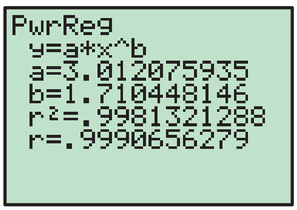
When we have data for two variables x and y, we can use power regression to find the power model of the form $y = a \times x^b$ which best fits the data.

We will examine the power relationship between x and y for the data:

x	1	3	4	6
y	3	19	35	62

Texas Instruments TI-84 Plus

Enter the x values into **L1** and the y values into **L2**.



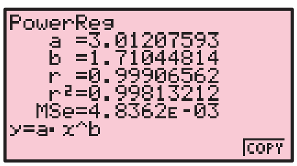
Press [STAT] [▶] , then scroll down to **A: PwrReg** and press [ENTER] .

Press [2nd] 1 **(L**$_1$**)** [,] [2nd] 2 **(L**$_2$**)** [ENTER] .

So, the power model which best fits the data is $y \approx 3.01 \times x^{1.71}$.

Casio fx-9860g

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



Press [F2] **(CALC)** [F3] **(REG)** [F6] [F3] **(Pwr)**.

So, the power model which best fits the data is $y \approx 3.01 \times x^{1.71}$.