## How Do I ......... on a CASIO ClassPad II <br> The Next Generation



Elena Zema

## How do I <br> on a CASIO ClassPad II?

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Questions about this publication should be directed to support@stepsinlogic.com

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## 1. Out of the box

### 1.1 What's what...

Before we get started, let me introduce you to the ClassPad II!


The basic overview

## Front

Touch Screen
This is the view screen of the ClassPad. Use your finger or the supplied stylus to tap on the touch screen to input data, perform calculations and so on.

## Cursor Keys

These keys work in the same manner as computer cursor keys.

## Stylus

The stylus has been designed to perform various touch screen operations (by pressing the stylus against the touch screen).

## Icon panel

The icon panel contains seven permanent icons. These applications can be executed by selecting an icon with the stylus.

## Keyboard key

This key turns on and off the display of the soft keyboards.
$\longleftarrow$ key
This is the delete key. This key can also be used to pause the processing of various operations.

## cuClear key

Turns the ClassPad on and off (press Shift first to action off).
It also clears all data in the current working line. This key can also be used to interrupt the processing of various operations.

## Keypad

This is the 'hard' keyboard.

## Shift key

This key is used to access the second function of each key on the hard keyboard. (See Section 1.15 for the default key assignments.)

EXE] key
The execute key.

## Top

| 3-pin data communication port. | 4-pin mini USB port. | Stylus storage. |
| :--- | :--- | :--- |

## Back

Restart button
This is not a reset button. This button restarts the ClassPad. No settings are changed and no data is lost.

Battery compartment -four AAA batteries (either alkaline or rechargeable Ni-MH).

### 1.2 Straight out of the box

When you first take your ClassPad from its box you will need to do a series of things:
Insert the four AAA batteries. Either alkaline or Ni-MH (Nickel-metal hydride) batteries.


Turn the ClassPad over and see if it has turned on. If it has you will see the Touch Panel alignment screen. Remove the stylus from the rear of the ClassPad and use it to accurately touch (once), the centre of each of the four target crosses. Once touched they will grey-out.

## Language

x
Set the system language.


Tap Set to select the language in which you wish the menus to be displayed.
Select the keyboard format.

$\qquad$

Select the keyboard format you wish to be displayed.

## Battery Settings

Select the type of batteries that are loaded.


Select the Battery Settings. Be sure to select the correct type of batteries that you have loaded into the ClassPad.


Note: A Warning window will appear to ensure the correct selection.


The ClassPad Application MENU should now be visible.
You are ready to start!

### 1.3 Not straight out of the box

If your ClassPad is not straight from the box, some of its settings may be different to the factory (or default) settings. This may hinder your progress if you are a first time user of the ClassPad.

If you are a first-time user of the ClassPad, we suggest you reset your ClassPad before working through this book. Note that resetting will erase information saved on the ClassPad by previous users. If you do not wish to erase the information then do not carry out the steps shown below. Alternatively, back up the information on the ClassPad first and then reset it. See Chapter 14, Managing your ClassPad II, for details on how to backup your ClassPad's saved information.

Do the following to reset the ClassPad.


Press the UClear button to turn the ClassPad on.


Tap the Reset icon.

Select Variable/Program and tap Reset.
Note that any eActivities and/or files/pictures in the Storage Memory saved on the ClassPad will not be deleted. They will not hamper your progress if you are a first-time user.

Tap OK.


The ClassPad will return to the Application MENU

If you are having problems using the stylus on the touch screen, or if you wear glasses, it is suggested you realign the touch screen.

To realign the touch screen:
Tap MENU then select Touch Panel Alignment.

Use the stylus to touch the center of each cross on the screen.


You are ready to start!

## Note

If the ClassPad does not seem to be responding at any time, use a thin blunt object to gently press the RESET button on the back of the ClassPad to restart it.

### 1.4 To use the stylus or not to use...

ClassPad II is designed to be 'finger driven', however for 'fine detail' work, as in the Geometry application, the stylus is available and very useful.

Now before we continue, let's explain how the screen works.
You can 'tap', 'double tap' and 'drag' with either your finger or the stylus.
When you tap your finger or the stylus onto the screen to execute an operation, the operation is performed as your finger comes off the screen. It works similar to a computer mouse click.

### 1.5 Some first steps

Excited and scared all at the same time?
Take that cover off and let's get started.


Press the JClear button to turn the ClassPad on.
Tap ${ }^{\text {Menu }}$ on the icon panel to show the ClassPad Menu.

This is your 'desktop'.
Use your finger (or stylus) to either tap the screen selector or drag/slide the screen in order to view other icons in the
Application Menu.
To launch an application, simply tap the icon.



If the work area is filled with calculations you may want to clear it.

To clear the work area:
Tap Edit followed by Clear All.

The Clear All dialogue box will appear.
Tap OK.
The calculation history will now be cleared from the work area.


Look at the status bar (bottom of the screen). Do you see the words Alg, Standard, Real and Rad? If different words are visible, tap each word until they are as stated above.

An almost empty screen awaits you.

Notice that the cursor is flashing to the left of an empty box. This signifies the calculator is ready for you to enter a calculation.


Calculate $325 \div 31$.
Enter $3 \times 5 \div 3$
To have a calculation performed and the result displayed, press the blue EXE key at the bottom right corner of the calculator.

The result is shown on the right side of the screen. Not such a belpful result I bear you thinking!

Note the word Standard at the bottom of the screen. Tap the word Standard and note it changes to Decimal. Now all answers will be displayed in decimal form.


Press EXE again.
Note ans will appear on the next input line. The ClassPad assumes you want to calculate the same result again.

We now see the result of 10.48387097 .


To see the fractional form of this decimal, tap once on the output and notice that the entire output is selected.

Now tap $\xlongequal[\substack { 0.5,1 \\ \begin{subarray}{c}{4 \\ \hline 2{ 0 . 5 , 1 \\ \begin{subarray} { c } { 4 \\ \hline 2 } } \\{\hline 1}\end{subarray}]{\substack{1 \\ \hline}}$. Now the fractional form is displayed.


To change the mode that the ClassPad is currently operating in, you can simply tap on the mode name in the status bar to change it. Alternatively, tap on the menu bar.

## Status Bar Mode Indicators



Settings that are marked with an asterisk (*) in the following tables are initial defaults.

| Status Bar Location | Indicator | Description | Setting | Status |
| :---: | :---: | :---: | :---: | :---: |
| （1） | Assist | Assistant mode：Does not automatically simplify expressions． | Assistant | On |
|  | Alg | Algebra mode：Automatically simplifies expressions． |  | Off＊ |
| （2） | Decimal | Decimal mode：Converts result to a decimal（approximate value）． | Decimal Calculation | On |
|  | Standard | Standard mode：Displays result in exact form（fractional format）．If a result cannot be displayed in exact form，however，it will be displayed as a decimal approximation． |  | Off＊ |
| （3） | Cplx | Complex mode：For complex number calculations． | Complex Format | On |
|  | Real | Real mode：For real number calculations． |  | Off＊ |
| （4） | Rad | Radian mode：Angles displayed in radians． | Angle | Radian＊ |
|  | Deg | Degree mode：Angles displayed in degrees． |  | Degree |
|  | Gra | Grad mode：Angles displayed in grads． |  | Grad |

## 1．6 Keyboards and the Interactive menu

Up until now，we have only utilised the hard keyboard．
Where are all the＇other＇buttons？

Press the Keyboard button．


There are three main soft keyboards；Math1，Math2，and Math3
Tap each tab in turn to see what the keyboards offer．

| Math1 | Line | 틈 | $\sqrt{\square}$ | $\pi$ | $\Rightarrow$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Math2 | $\square^{\square}$ | $e^{\text {a }}$ | ln | $i$ | $\infty$ |
| Math3 | ［ | $\frac{\mathrm{d}}{\mathrm{d}} \mathrm{\square}$ | $\frac{d^{\text {a }}}{\text { d }}$ | $\int_{\square}^{\text {口 }}$ | $\lim _{\square \rightarrow \square}$ |
| Trig | ［10］］ | ［里］ | ［㧽］ | 比口 | 高口 |
| Var | sin | cos | tan | $\theta$ | $t$ |
| V | 4 |  | 㽞 | ans | EXE |


| Math1 | Line | 듬 | $\sqrt{\square}$ | $\pi$ | $\Rightarrow$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Math2 | Define | f | g | $i$ | $\infty$ |
| Math3 | solve（ | dSlv | ， | \｛袁 | I |
| Trig | ＜ | ＞ | （） | \｛ \} | ［］ |
| Var | $\leq$ | $\geq$ | ＝ | \＃ | ＜ |
| abc |  |  |  |  |  |
| V | 4 | 㲯 | 品 | ans | EXE |


| \％Edit Action Interactive |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\bullet\left[\begin{array}{c}\text { dix } \\ \mathrm{dax}\end{array}\right]$ | Simp | $\stackrel{\text { Sax }}{0}$ | －$\psi$ | － |
| － | $\nabla$ |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| Math1 Line旦 <br> 1 <br> ■ | Line | 旦 | $\sqrt{\square}$ | $\pi$ | $\Rightarrow$ |
| Math2 | $\square^{\square \prime}$ | $e^{\square}$ | ln | log．${ }^{\text {－}}$ | $\sqrt{\square}$ |
| Math3 | ［｜］ | $\mathrm{x}^{2}$ | $\mathrm{x}^{-1}$ | $\log _{10}(\mathbf{I})$ | solve（ |
| Trig | －10 | toDMS | \｛昌 | \｛ \} | （） |
| Var | $\sin$ | $\cos$ | tan | 。 | ${ }^{*}$ |
| abc |  |  |  |  |  |
| $\checkmark$ | 4 | 廐 | 畹 | ans | EXE |
| Alg | Standa | ard | Real | Rad | 石 |

Use the hard keyboard to enter the calculation.
The calculation can also be entered using natural input templates from the Math1 soft keyboard.

This is the preferred method and will be used throughout the remainder of this book.


However, we are not limited to only these 'buttons', there are more options available in the Interactive menu (can be found on the Menu bar).

Also, commands not found in here can be found in the Catalog ue.



Is $6^{4}<4^{6}$ ?
The judge ( function will judge the validity of an equality or inequality. Use the Catalog ue soft keyboard to enter judge ( or just type it in.

Use the Math3 soft keyboard in order to enter the inequality sign.



Find prime factors of 360 ？
Key in the number and select it．
Tap the Interactive option on the menu bat，tap Transformation，factor and then select factor．


Evaluate $\log _{10} 324$

The calculation can be entered using natural input via the Math1 soft keyboard．

Note：Logarithms of bases other than 10 can be computed using the $\log _{\square}$ button．


Calculate $\lim _{x \rightarrow 2}\left(\frac{1}{x-2}\right)$ ．
In the $\sqrt{\sqrt{\alpha} \text { main }^{2}}$ application，enter the expression $\left(\frac{1}{x-2}\right)$ ．Then select it by
dragging across the expression with the stylus．Then tap the Interactive menu，select Calculation and then lim．
You can see that a dialogue box appears prompting you to input the required information－no recall of syntax required．Entering the correct inputs and tapping $O K$ returns the result．


| lim |  |  |  |  | $x$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Expression： <br> Variable： <br> Point： <br> Direction： |  | $((1) /(x-2))$ |  |  |  |
|  |  | x |  |  |  |
|  |  | 2 |  |  |  |
|  |  | －1］ |  |  |  |
| OK |  |  |  | Cancel |  |
| Math1 | Line | 듬 | $\sqrt{\square}$ | $\pi$ | $\Rightarrow$ |
| Math2 | $\square^{\square}$ | $e^{\square}$ | ln | $\log _{\square} \square$ | $\sqrt{\square}$ |
| Math3 | － | $\mathrm{x}^{2}$ | $\mathrm{x}^{-1}$ | $\log _{10}(\mathrm{I})$ | solve（ |
| Trig | － | toDMS | \｛里 | \｛ \} | （） |
| Var | sin | $\cos$ | tan | － | r |
| abc |  | 覧 |  |  |  |
| V | 4 |  | － | ans | EXE |
| Standard |  |  | Real | Rad | 且 |



### 1.7 The basics about variables

You will notice on the hard keypad the keys $x>y$. When pressed they input an italic letter.

ClassPad understands $x y z$ to be $x \times y \times z$, thus removing the need to enter multiplication signs all the time.

This feature helps us to enter algebraic expressions as we see and write them (without multiplication signs).

However, you can also input letters using the abc soft keyboard. Note that when doing this, the letters are not bold. ClassPad understands $x y z$ to be the name of a variable. If we include multiplication signs $(\mathbf{x} \times \mathbf{y} \times \mathbf{z})$ the ClassPad will interpret the input as three variables multiplied together.


We are not restricted to just $x$ $y$ and $z$ on the hard keyboard.
The Var soft keyboard holds 52 variables for you to use.



### 1.8 Defining variables to have a numerical value

Example:
a) Find the hypotenuse, $b$.
b) Find the angle, $\theta$.


11

Using Pythagoras' Theorem, assign the following; $a=11, o=4, h=\sqrt{\left(a^{2}+o^{2}\right)}$. The angle, $\theta$ can be found using $\theta=\sin ^{-1}\left(\frac{o p p}{h y p}\right)$.
Use the variable assignment key $\Rightarrow$, to assign a numerical value to a variable (from the Var soft keyboard). This key can be found on the Math1, Math2, Math3 and Trig soft keyboards.

The value of entering the calculation in this way is that the values of $a$ and $o$ can be changed and the cursor placed in the first line and EXE pressed all calculations below will be re-calculated.



Note that variables need to be clear of defined numeric values before doing symbolic calculations.

To be sure the variables $\boldsymbol{a}$ to $\mathbf{Z}$ (both lower and upper case) are not defined as a numeric value, use the Clear All Variables command in the Edit menu.


### 1.8.1 All about variables

Numbers, lists, matrices can be stored as a 'name' using variables.

There are 52 single alphabet variables that can be found on the Var soft keyboard.


| Math1 | $A$ | B | C | D | $E$ | $F$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Math2 | $G$ | H | $I$ | $J$ | K | $L$ |
| Math3 | M | $N$ | 0 | $P$ | Q | $R$ |
| Trig | $S$ | $T$ | $U$ | V | W | $X$ |
| Var |  |  |  |  |  |  |
| abc | $Y$ | $Z$ |  |  |  | caps |
| V | 4 | 暨 | C |  | ans | EXE |
| Alg | Stanc | ard | Real | R | Rad | 血 |

However, you can make you own 'names' with the abc soft keyboard.


## Where are they stored?

Variables are stored in the current working folder.

## Where do I find the current working folder?

Tap Settings , then Variable Manager. In this instance, the current working folder is main. You can see that there are four variables currently stored in this folder (you may have more or less).
If you double tap on this folder, it will open and you can view the stored variables.




How do I clear a variable？
There are four different ways to delete a variable．

Method 1：
Tap Edit then；
Clear All Variables
This method clears all assigned variables．

A dialogue box will appear to make sure you want to clear all variables．


Method 2：

Tap Action，Command then；

```
Clear_a_z
```

Tap EXE．
This method clears all＇single letter＇variables．



Method 3：
Tap Action，Command then；
DelVar（enter variable）

Tap EXE．
This method clears only the variables you enter to be cleared．

In the example opposite，only matrix $A$ has been cleared（from the current working folder）．

| \％Edit Action Interactive |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| ${ }^{0.5} \frac{1}{4} \frac{1}{2}$ S |  | Transformation |  |  |  |  |  |
|  |  |  | Advanced |  |  |  |  |
|  |  |  | latio |  |  |  |  |
|  |  |  | Complex |  |  |  |  |
|  |  |  |  |  |  |  |  |
|  |  |  | Matrix |  |  |  |  |
|  |  |  | Vector |  |  |  |  |
| $\left[\begin{array}{ll} 4 & 5 \end{array}\right]^{3}$ |  | Equation／Inequality |  |  |  |  |  |
|  |  |  | tant |  |  |  |  |
| D |  | Distribution／Inv．Dist |  |  |  |  |  |
|  |  |  |  |  |  |  |  |
| abc |  | Command |  | Define |  |  |  |
| 1 | 2 | 3 | 5 | DispStat |  |  |  |
|  |  |  |  | Clear＿a＿z |  |  |  |
| q | w | e r | t | DelVar |  |  |  |
| a | s | d | g | Clear All Variables |  |  |  |
| 4 | z | x | v | b n m | m |  |  |
| $\checkmark$ |  | 4 |  | Space |  |  |  |
| Alg |  | Standard |  | Real |  |  | 四 |


| Edit Action Interactive |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| ${ }_{0}^{0.5} \frac{1}{2}$（the | ${ }_{\text {d }}^{\text {d }}$ | Simp | d ${ }^{\text {dx }}$ | － |  | － |
| $\left[\begin{array}{ll} 3 & 2 \\ 4 & 5 \end{array}\right] \Rightarrow A$ |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| Delvar $A$ |  |  |  |  |  |  |
| $\square$ |  |  |  |  |  |  |
| Math1 | $A$ | $B$ | C | D | $E$ | $F$ |
| Math2 | G | H | $I$ | $J$ | K | $L$ |
| Math3 | M | $N$ | O | $P$ | Q | $R$ |
| Trig | $S$ | $T$ | $U$ | $V$ | W | $X$ |
| Var |  |  |  |  |  |  |
| abc | $Y$ | $Z$ |  |  |  | caps |
| v | 4 | 暨 | 品 |  | ans | EXE |
| Alg | Stand | ard | Real | R | Rad | till |

Method 4:

Tap Settings $\boldsymbol{*}$, then
Variable Manager.
In this instance, the current working folder is main. You can see that there are four variables currently stored in this folder (you may have more or less). If you double tap on this folder, it will open and you can view and delete the stored variables.


Select the variable(s) you wish to delete by checking the box in front of the variable.

Tap Edit, then Delete.
A dialogue box will appear to make sure you want to delete the selected variable(s).


Tap $O K$ and the folder will be
 clear of the deleted variable(s).

## 1．9 Basic function calculations

Evaluate $x^{2}+2 x+2$ when $x=4$ ．
Method 1：
Raise the Math3 soft keyboard．
Tap Define， f and key in the equation and press EXE．

Now type in $f(4)$ and press EXE．
（You could also use the text $\mathbf{f}$ on the abc soft keyboard to define the function，but not a variable．）


Method 2：
Key in the equation and highlight．

Tap Interactive on the menu bar，then tap Define．

Enter the function name and variable／s into the Define dialogue box．（The
Expression should already be entered．）Tap OK．

Now type in $f(4)$ and press EXE．

| \％Edit Action |  | Interactive |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Transformation Advanced |  |  |  |
| $x^{2}+2 x+2$ |  | Calculation Complex |  |  |  |
| $\square$ |  | List <br> Matrix <br> Vector <br> Equati <br> Assist <br> Distrib <br> Financ | ion／In <br> tant <br> bution <br> ial | quality <br> Inv．D | st |
| Math1 | Line | Define |  |  |  |
| Math2 | $\square^{\square \prime}$ | $e^{\square}$ | ln | $\log ^{\square}$ | $\sqrt{\square}$ |
| Math3 | － | $\mathrm{x}^{2}$ | $\mathrm{x}^{-1}$ | $\log _{10}(\mathrm{I})$ | solve（ |
| Trig | －10 | toDMS | \｛昌 | \｛ \} | （） |
| Var | sin | cos | tan | － | r |
| abc |  |  |  |  |  |
| V | $\leftarrow$ | 暨 | 噌 | ans | EXE |
| Alg | Standa |  | Real | Rad | 监 |



## 1．10 Working with angles

When working with angles，always begin by checking that the ClassPad is set to compute in the angle units you are working with．Look at the status bar to find out which angle the ClassPad is set to use．The default setting is radians．
Note：The ClassPad utilizes ${ }^{\boldsymbol{I}}$ ，not ${ }^{\boldsymbol{c}}$ ，as a notation for the units of radians．

It may be useful，when working with degrees（or when you require a decimal approximation and not an exact value），to set the ClassPad to output the approximate decimal answer．See the next section for details．

### 1.10.1 Output: degrees and decimal approximation

To change the angle mode the calculator is operating in, simply tap on the angle unit in the status bar.

Similarly, tap the word Standard in the status bar to change
 it to Decimal.

Notice the status barhas changed, and the ClassPad will now be operating in degrees and return outputs that are decimal approximations (rather than exact values.)


### 1.10.2 Degrees to degrees, minutes and seconds

Express $34.65^{\circ}$ in degrees, minutes, seconds.

Tap toDMS on the Math1 soft keyboard.

Enter the angle and press EXE.


### 1.10.3 Degrees, minutes and seconds to degrees

Express $34^{\circ} 39^{\prime}$ as a decimal degree value.
Tap (dms key) on the Math1 soft keyboard.
Enter the angle and press EXE.


### 1.10.4 Convert angles in degrees to radians

Express $34^{\circ} 39^{\prime}$ in radians.

Tap (dms key) on the Math1 soft keyboard.
Tap on the angle unit in the status bar to change to Radians.
Enter the angle, including the degree symbol, $\square$, and press EXE.

## Note

It is in this situation that the inclusion of the degree symbol is critical. It tells the ClassPad your input is in degrees. Without this, it would assume the input is in radians as the ClassPad is set to radian mode.


### 1.10.5 Convert angles in radians to degrees

Express $\frac{5 \pi^{c}}{11}$ in degrees, minutes, seconds.
Tap on the angle unit in the status bar to change to Degrees.
Tap tooms and enter the angle, including the radian symbol, $\square$ and press EXE.

Note:
It is in this situation that the inclusion of the radian symbol is critical. It tells the ClassPad your input is in radians. Without this, it would assume the input is in degrees as the ClassPad is set to degree mode.


To convert from the exact value to the decimal approximation, highlight the answer and tap $0.5 \frac{1}{2}$. (Or, tap Standard on the status bat. This will change the settings to Decimal. Then recalculate.)

### 1.11 Basic trigonometric calculations

When working with angles, always begin by checking that the ClassPad is set to compute in the angle units you are working with. Look at the status bar to find out which angle the ClassPad is set to use. The default setting is radians.
Note: The ClassPad utilizes ${ }^{\boldsymbol{r}}$, not ${ }^{\boldsymbol{c}}$, as a notation for the units of radians.
It may be useful, when working with degrees (or when you require a decimal approximation and not an exact value), to set the ClassPad to output the approximate decimal answer.

This section assumes you have read Section 1.10.

Evaluate $\sin \left(25^{\circ} 42^{\prime}\right)$.
Set angle mode to degrees.
On the Math1 soft keyboard, tap sin, then (dms key).
Enter the angle and press EXE.


Evaluate $\cos \left(\frac{5 \pi^{c}}{7}\right)$
Set angle mode to radians.
Use the Math1 soft keyboard to enter the trigonometric function and enter the angle.

Press EXE.


Find $\theta$ in radians if $\sin \theta=0.3$.
Set angle mode to radians.
Use the Trig soft keyboard to key in expression.

Press EXE.


Find $\theta$ in degrees, minutes and seconds if $\cos \theta=0.75$.
Set angle mode to degrees.
Tap toDMS on the Math1 soft keyboard.
Then use the Trig soft keyboard to key in expression.
Press EXE.


### 1.12 Basic random number generation

The random number generator on the ClassPad can generate:

- Non-sequential random numbers.
- Sequential random numbers.

The ClassPad has five 'random' functions:

- rand - generates random numbers.
- randList - generates a list of random numbers.
- RandSeed - configures settings for random number generation (i.e. switch between nonsequential and sequential). The ClassPad can generate nine different patterns of sequential random numbers - this function is also used to choose a specific pattern.
- randBin - generates binomial random numbers based on the number of trials, $n$ and the probability, p .
- randNorm - generates a 10 digit normal random number given mean, $\mu$ and standard deviation, $\sigma$.


## rand function

Generate random numbers between 0 and 1 .
Type in, or locate in the Catalog ue, $r$ and $($.
Press EXE.

To generate more random numbers, simply press EXE again.


Generate random integers between 25 and 50 inclusive.
Type in, or locate in the Catalog ue, rand (. Enter the start and end values separated with a comma.

Press EXE.
To generate more random numbers using these limits, simply press EXE again.


## randList function

Generate 20 random numbers between 0 and 1 .

Type in, or locate in the Catalog ue, $r$ andList $($.
Enter the number of random numbers you wish to find and close with a bracket.

Press EXE.


Generate 20 random integers between 1 and 100 inclusive.

Type in, or locate in the Catalog ue, randList (
Enter 20,1,100 and close with a bracket.

Press EXE.


## RandSeed function

This command requires an integer between 0 and 9 for the argument.
RandSeed (0) results in non-sequential random number generation.
RandSeed (integer from 1 to 9 ) results in that particular value as the seed for sequential random number generation.

Generate sequential random numbers using 4 as the seed value.
Type in RandSeed (and a space) or locate it in the Catalog ue. Enter 4, then press EXE.

To generate random numbers - Type in/ or locate rand (in the Catalog ue. Press EXE.

To generate more random numbers, simply press EXE again.


## randBin function

Example:
It is claimed that 1 in every 10 plastic bags made by a company are not water tight - they leak. The bags are sold in packets of 50 bags.

If I was to buy 100 packets, how many 'leakers' might I expect in each of my 100 packets?

Generate a binomial list of 100 random numbers, where $\mathrm{p}=0.1$ and $\mathrm{n}=50$.

Type in, or locate in the Catalog ue, randBin (.
Enter 50,0.1,100 and close with a bracket.
Press EXE.


Search the list.

You can also generate this list in the application which makes investigating the list simpler.

## randNorm command

Using a normal distribution with standard deviation 20，mean 60，sample 100 values．

Type in，or locate in the Catalog ue，randNorm（．

Enter 20，60，100 and close with a bracket．

Press EXE．

You can also generate this list in the （G）statistics application which makes investigating the list simpler．


## 1．13 Basic symbolic calculations

When entering variables it is good practice to use the italic letters available on the hard keyboard and on the Var soft keyboard．See the Section 1.7 for reasons．

| Math1 | $a$ | $b$ | $c$ |  | $d$ | $e$ | $f$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Math2 | $g$ | $h$ | $i$ |  | $j$ | $k$ | $l$ |
| Math3 | $m$ | $n$ | $o$ |  | $p$ | $q$ | $r$ |
| Trig | ， | n | $u$ |  | $v$ | $w$ | $\boldsymbol{x}$ |
|  | $y$ | $z$ |  |  |  |  | caps |
| －${ }^{\text {V }}$ | $\leftarrow$ | 艮暨 |  | 膤 |  | ans | EXE |



To achieve answers in the same format as those displayed in the following examples，tap and select Basic Format．

Under the Advanced options， tick Descending Order．

Tap Set．

Variables that are defined with a numerical value can cause problems when doing symbolic calculations．

To be sure the variables $\boldsymbol{a}$ to $\mathbf{Z}$ are not defined as a numeric value use the Clear All Variables command in the Editmenu．


Simplify $3 x+2 x+a x$
Enter the expression and press EXE．


Simplify $\frac{\left(x^{2}-y^{2}\right)}{(x+y)}$

Key in the expression and highlight．

Tap Interactive on the menu bar，
Transformation，then tap simplify．

| \％Edit Action Interactive |  |  |
| :---: | :---: | :---: |
| approx | Transformation |  |
| simplify | Advanced <br> Calculation <br> Complex <br> List <br> Matrix <br> Vector <br> Equation／Inequality <br> Assistant <br> Distribution／Inv．Dist <br> Financial <br> Define |  |
| expand |  |  |
| factor |  |  |
| combine |  |  |
| collect |  |  |
| tExpand |  |  |
| tCollect |  |  |
| expToTrig |  |  |
| trigToExp |  |  |
| Fraction |  |  |
| DMS |  |  |



Expand
a．$(x+y)^{2}$
b．$(x+y)^{4}$

To save time when entering b）， highlight the input of a），drag and drop it into a new working line and then edit the 2 to be a 4 ．

Press EXE．

| \％Edit Action Interactive |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| approx <br> simplify |  | Transformation |  |  |  |
|  |  | Advanced <br> Calculation <br> Complex <br> List <br> Matrix <br> Vector <br> Equation／Inequality <br> Assistant <br> Distribution／Inv．Dist <br> Financial <br> Define |  |  |  |
| expand |  |  |  |  |  |
| factor combine collect |  |  |  |  |  |
| tExpand tCollect |  |  |  |  |  |
| expToTr trigToEx |  |  |  |  |  |
| Fraction DMS |  |  |  |  |  |
| Math2 | $\square^{\square}$ | $e^{\square}$ | ln | $\log _{\square}$ | $\sqrt{\square}$ |
| Math3 | $\square$ | $\mathrm{x}^{2}$ | $\mathrm{x}^{-1}$ | $\log _{10}(\mathbf{I})$ | solv |
| Trig | － | toDMS | \｛昌 | \｛ \} | （） |
| Var |  |  |  |  | r |
| abc | sin | cos | tan |  |  |
| V | $\leftarrow$ | 廐 | 㽞 | ans | EXE |
| Alg | Standa | ard | Real | Rad |  |


| \％Edit Action Interactive |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |
| $\begin{aligned} & \operatorname{expand}\left((x+y)^{2}\right) \\ & \operatorname{expand}\left((x+y)^{4}\right) \\ & x^{4}+y^{4}+4 \cdot x^{2} \cdot y+4 \cdot x \cdot y^{3}+6 \cdot x^{2} \cdot y^{2} \end{aligned}$ |  |  |  |  |  |
| Math1 | Line | 旦 | $\sqrt{\square}$ | $\pi$ | $\Rightarrow$ |
| Math2 | $\square^{\square}$ | $\boldsymbol{e}^{\square}$ | ln | $\log _{ \pm}$ | $\sqrt{\square}$ |
| Math3 | $\square$ | $\mathrm{x}^{2}$ | $\mathrm{x}^{-1}$ | $\log _{10}(\mathrm{I})$ | solve（ |
| Trig | M0］ | toDMS | \｛吕 | \｛ \} | （） |
| Yar | $\sin$ | cos | tan | － | r |
| abc |  |  |  |  |  |
| － | － | 暨 | 㑑 | ans | EXE |
| Alg | Standa |  | Real | Rad | 监 |

Factorise $x^{2}-16$

| \％Edit Action | Interactive |
| :--- | :--- | :--- |
| approx | Transformation |
| simplify | Advanced |
| expand | Calculation |
| factor | factor |
| combine | rFactor |
| collect | factorOut |
| tExpand | Vector |
| tCollect | Equation／Inequality |
| expToTrig | Assistant |
| trigToExp | Distribution／Inv．Dist |
| Fraction | Financial |
| DMS | Define |



Factorise $x^{2}-6$ ：
a）over Q －the rational numbers
b）over $R$－the real numbers


Divide $5 x+1$ by $x-2$ ．

| \％Edit Action Interactive |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| approx |  | Transformation |  |  |  |
| simplify |  | Advanced |  |  |  |
| expand |  | Calculation |  |  |  |
| factor |  | Complex |  |  |  |
| combine |  | List |  |  |  |
| collect |  | Matrix |  |  |  |
| tExpand tCollect |  | Vector |  |  |  |
|  |  | Equation／Inequality |  |  |  |
| expToTrig <br> trigToExp |  | Assistant |  |  |  |
|  |  | Distribution／Inv．Dist |  |  |  |
| Fraction |  | toFrac |  |  |  |
| DMS |  | propFrac |  |  |  |
| Math2 | h2 $\square^{\text {■ }}$ | $e^{\text {■ }}$ | ln | $\log _{\square} \square$ | $\sqrt{\square}$ |
| Math3 |  | $\mathrm{x}^{2}$ | $\mathrm{x}^{-1}$ | （1） | solve（ |
| Trig |  |  |  |  | （） |
|  | － 1 | to DMS | \｛모 | \｛ \} |  |
| Var |  | $\cos$ | $\tan$ |  | $r$ |
| abc | － $\sin$ |  |  | $\bigcirc$ |  |
| V | 4 | 覧 | 曾 | ans | EXE |
| Alg | Standard |  | Real | Rad | 且 |



Find the partial fraction
expansion of $\frac{7 x+3}{(x+3)(x-6)}$ ．
Enter the fraction，highlight it and then from the
Interactive menu and the Transformation sub－menu， select expand．

Enter $x$ as the variable and check Partial Fraction．

Tap OK．


Express $\frac{5}{2 x}+\frac{3}{3 y}$ as a single fraction．

| \％Edit Action Interactive |  |  |
| :---: | :---: | :---: |
| approx | Transformation | ， |
| simplify | Advanced |  |
| expand | Calculation | ， |
| factor | Complex | ， |
| combine | List |  |
| collect | Matrix |  |
| tExpand | Vector |  |
| tCollect | Equation／Inequality |  |
| expToTrig | Assistant |  |
| trigToExp | Distribution／Inv．Dist | ， |
| Fraction | Financial | ， |
| DMS | Define |  |


| \％Edit Action Interactive |  |  |  |
| :---: | :---: | :---: | :---: |
| 0 |  | $\xrightarrow{\text { dx }}$ ）$\|l\| l^{*}$ |  |
| $\text { combine }\left(\frac{5}{2 x}+\frac{3}{3 y}\right)$ |  |  |  |
| （ $\quad \frac{2 \cdot x+5 \cdot \mathrm{y}}{2 \cdot \mathrm{x} \cdot \mathrm{y}}$ |  |  |  |
|  |  |  |  |
|  |  |  |  |

Solve $\sin 2 x=\frac{1}{2}$,
a) for all $x$.
b) for $0<x<2$.

Enter in the equation and highlight.

| \% Edit Action | Interactive | $\times$ |
| :---: | :---: | :---: |
|  | Transformation Advanced | * |
| $\sin (2 x)=\frac{1}{2}$ | Calculation | * |
|  | Complex | * |
|  | List | , |
|  | Matrix | , |
|  | Vector | * |
|  | Equation/solve |  |
|  | Assistant dSolve |  |
|  | Distribut rewrite |  |



Select Interactive, Equation/Inequality then solve.
Use the "for" operator, $\square$, to key in the condition.
(The Math3 tab, holds the "for" operator.)

Tap $\stackrel{\text { Rotate }}{1 / 2}$ on the icon panel to
 view the solution in widescreen.

## Simultaneous Equations

Solve the following simultaneous equations:
$-x+3 y=15$
$y=2 x+5$
Key in the function, using the
图 template on the Math1 soft keyboard.

Note: To enter a system with more than 2 equations, repeatedly tap the $\{$ template.


Solve $F=\frac{9}{5} C+32$ for $C$.

Enter in the equation and highlight.

Select Interactive, Equation/Inequality then solve.

Set the Variable (you are solving for) to C.

Tap OK.


### 1.14 Active windows, menus and tool bars

The ClassPad has a large screen. It allows us to have two applications visible the same time.
 visible at once. You will make use of this in this section.

Solve $x^{2}-7<0$ for $x$.
The ClassPad can display the solution to this inequality both numerically and graphically.

To see the solution graphically:

Tap $\forall$ to open the graph application. Select the inequality, then "drag and drop" it from Main to the Graph window. The graph
 window will illustrate the values of x for which the inequality is true.

We now have two windows open, one with the bold blue boundary and one not. The blue border indicates which is the active window. Notice that the menu bar options and the tool bar change depending which windows is active. The menu baroptions and the icons on the tool bar belong to the application whose window is active. This is an important thing to remember as we proceed.

### 1.15 Default shift key assignments

Even though it may not look like it, each key on the hard keyboard has a second function.
Press Shift first to access the second function of a key. The defaults seconds functions are as follows:

| ( ${ }^{\text {: Copy }}$ | X : Cut | $\boldsymbol{y}$ : Paste | (z) : Undo |
| :---: | :---: | :---: | :---: |
| $\square$ : $t$ | 1) : $\theta$ | , ${ }^{\text {a }}$ | $(-): \Rightarrow$ |
| 7 : $\sin ($ | 2] : $\cos ($ | 3 : $\tan$ ( | 4- $\mathrm{e}^{\text {- }}$ |
| 5 : $\ln ($ | [6] : $\underline{\log 0}$ | 7 : no assignment | 8 : no assignment |
| 9 : no assignment | O: $\pi$ | $\square: i$ | EXP : $\infty$ |
| EXE : Ans | , | $\div$ : | X : no assignment |
| $\square$ : no assignment | $\pm$ : no assignment |  |  |

To change the default settings for the Shift key; launch the ${ }^{8 i y}$ system application.

Tap the shift icon.
The Shift Key Assign dialogue box will appear.

Tap to select the hard key to which you want to assign a shift mode operation.

Specify the operation you wish to assign (choose from the soft keyboards), tap Set then tap OK.

The operation assigned to the hard key is displayed in the


## 2．How do I．．．in Graph \＆Table？

## 2．1 Create a table of values

Tap 㗂品 on the icon panel．

Tap in the working line of y 1 （or an empty line）．Define $y l$ to be $3 x+5$ ．

Press EXE to complete the process．Notice the box in front of the function is now ticked．

Tap 娄萣 on the tool bar．This will display the Table Input box．

Enter the domain you are interested in as well as the steps within the domain to be displayed，and then tap OK．


| Table Input |  |  |  |  | x |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Start：－10 |  |  |  |  |  |
| End ： 10 |  |  |  |  |  |
| Step ： 1 |  |  |  |  |  |
| OK |  |  |  | Cancel |  |
| Math1 | Line | 틈 | $\sqrt{\square}$ | $\pi$ | $\Rightarrow$ |
| Math2 | $\square^{\square}$ | $e^{\square}$ | ln | $\log _{\text {■ }}$ | － |
| Math3 | － | $\mathrm{x}^{2}$ | $\mathrm{x}^{-1}$ | $\log _{10}(\mathbf{I})$ | solve（ |
| Trig | 10 | toDMS | \｛吕 | \｛ \} | （） |
| Var |  | cos | $\tan$ | － | r |
| abc | sin |  |  |  |  |
| $\checkmark$ | $\leftarrow$ | 艮筫 | 憎 | ans | EXE |
| Rad Real |  |  |  |  | d |

Select 㥱閏 on the tool bar．This will generate a table of values and will be displayed in a Table window．（Note that the menu bar and tool bar options change when the table window is active）．


Note：This process is a helpful guide to choosing sensible settings for the graph view window．

## Customising your plot view

Tap on the menu bar, or Settings on the icon panel.

Select Graph Format.

Check settings.
Tap Set.


### 2.2 Enter \& plot functions

There are two pathways that can be taken to plot functions:

1. via the
 application.
2. via the
 application.

Method 1.
Tap Menu on the icon panel. Open the ${ }^{\text {囲島 Trable }}$ Geplication.

Tap in the working line of $y l$ (or an empty line). Define $y l$ to be $3 x+10$.
Press EXE to complete the process. Notice the box in front of the function is now ticked.

Check the view window settings by tapping lated located on the tool bar. If necessary, change your window settings, and then tap OK.

Tap $\forall$ to have a graph of the function appear. (Note that the menu bar, tool bar options and status bar change when the graph window is active).


Method 2
Tap $\sqrt[M]{\alpha}$ min the icon panel.
Input the function. (In this example, $y=3 x+10$.)
Press EXE.
Insert a graph window by selecting $\forall$ from the tool bar. A graph window should appear. (Note that the menu bat, tool baroptions and status bar change when the graph window is active).


Highlight the entire function and drag it into the graph window. The graph of the function will appear in this window.

### 2.2.1 Using the trace function

The trace function allows you to move a cursor along a graph. The coordinates of the position of the cursor are displayed in the graph view window.

To operate the trace function, the graph view window needs to be active, tap in this window.

Tap the Analysis menu on the menu bar and select Trace.

Alternatively, tap on the tool bat.


The cursor will automatically be placed at $x=0$. The cursor can be moved along the graph by pressing the cursor key, left or right, or by tapping the left or right graph controller arrows (on the edges of the graph window).

If multiple graphs are sketched, press the cursor key, up or down, (or tap the up or down graph controller arrow) to jump between graphs.

If you wish to move the cursor to a specific $\boldsymbol{x}$-value, after activating the Trace function, press a number key to display the Enter Value box.

Key in the value and tap OK.



### 2.3 Finding significant points on a graph

At times, you will be required to do the following:

- Find $x$ and $y$ intercepts
- Find stationary points (ie. Maximum/minimum points, points of inflection)
- Calculate an $x$-value given a specific $y$-value or vice versa.

The following instruction will assume that you have already drawn a graph of the function.

### 2.3.1 Finding the $x$ intercepts)

The graph window needs to be active in order to use the appropriate tool bar.

Tap the Analysis option on the menu bar.
Tap G-solve, and then select Root.

Alternatively, tap $\square$ on the tool bar to scroll and view other options. Tap | $Y=0$ |
| :---: |
| $-\underbrace{}_{-}$ |

This will locate and display the $x$ intercept. Where there is more than one $x$ intercept to be found,
 simply use the cursor key (left and right) to allow the next intercept to be located.

### 2.3.2 Finding y intercept(s)

Tap the Analysis option on the menu bar.
Tap G-solve, and then select y-Intercept.

This function will locate and display the $y$ intercept.


### 2.3.3 Finding stationary point(s)

Maximum point(s)
Tap the Analysis option on the menu bar.
Tap G-solve, and then select Max.

Alternatively, tapon the tool barto scroll and view other options. Tap


This function will locate and display the local maximum point of the function within the bounds of the screen. Where there is more than one maximum point to be found, simply use the cursor key (left and right) to allow the next maximum point to be located.

## Minimum point(s)

Tap the Analysis option on the menu bar.
Tap G-solve, and then select Min.

Alternatively, tap $\square$ on the tool barto scroll and view other options. Tap



This function will locate and display the minimum point of the function. Where there is more than one minimum point to be found, simply use the cursor key (left and right) to locate the next minimum point

## Point(s) of inflection

Tap the Analysis option on the menu bar.
Tap G-solve, and then select Inflection.

This function will locate and display the point of inflection of the function. Where there is more than one point of inflection to be found, simply use the cursor key (left and right) to locate the next point of inflection.


### 2.3.4 To find an $x$-value given a specific $y$-value

Tap the Analysis option on the menu bar. Tap G-solve, x-Cal/y-Cal, and then select $\mathrm{x}-\mathrm{Cal}$.

This function will locate and display the $x$ and $y$ coordinates. Where there is more than one $x$ value given for a specific $y$-value to be found, simply use the cursor key (left and right) to allow the next $x$-value to be located.




### 2.3.5 To find a y-value given a specific $x$-value

Tap the Analysis option on the menu bat. Tap $G-$ solve, $x-C a l / y-C a l$, and then select $y-C a l$.

This function will locate and display the $y$ coordinates for a given $x$ coordinate.




### 2.4 Finding the intersection point(s) of two graphs

Tap the Analysis option on the menu bar. Tap G-solve, and then select Intersection.

This function will locate and display the intersection point of the graphs. Where there is more than one intersection point to be found, simply use the cursor key (left and right) to allow the next intersection point to be located.



Note: If three or more functions are drawn and the intersection of two is required, the ClassPad will flash the cursor on one function. Use the up and down cursor keys to select the functions you require and press EXE when the required function is selected.

### 2.5 Finding the distance between two points

This function will locate and display the distance between two specific points.
Tap the Analysis option on the menu bat, tap G-solve, and then select Distance.
Press a number key to display the Enter Value dialogue box. Key in the coordinates and tap OK. The coordinates will be displayed in the graph window and the distance calculated in the message box. Alternatively, you can use the stylus to tap the two points on the screen.


### 2.6 Configuring graph view window parameters

Tap 居? located on the tool bat.
(Or, tap $\boldsymbol{\#}$, then select View Window.) This feature displays the View Window dialogue box.


If necessary, make the appropriate changes, depending on the nature of the intended graph. Tap OK.
(Note: The menu bat, tool bar options and status barchange when the graph window is active).


Brief explanation of View Window parameters (rectangular coordinates):

| xmin-minimum value of $x$-axis | ymin-minimum value of $y$-axis |
| :--- | :--- |
| xmax-maximum value of $x$-axis | $y$ max-maximum value of $y$-axis |
| xscale-marker spacing of $x$-axis | $y$ scale - marker spacing of $y$-axis |
| xdot - value of each screen pixel <br> horizontally | $y$ dot - value of each screen pixel vertically |

The $x / y \operatorname{dot}$ and $x / y$ dot values will change automatically when the $x / y$ maximum and minimum values are changed.

A number of View Window configurations are saved in the memory of the ClassPad. Tap the Memory drop down menu when the view window setting input box is open.

You can also save your own
 settings using the File drop down menu.

### 2.7 Zooming the graph window



The ClassPad features an extensive selection of Zoom commands that can be used for either a specific region of a graph or to enlarge and/or reduce an entire graph.

Below is a brief explanation of some of the Zoom commands:

Initialize
This command allows you to quickly return to the default view window settings.


## Box

Select the Box zoom option from the Zoom menu or tap x , and then select a region of the graph you want enlarge with the stylus by dragging a rectangle on the screen.

Once the stylus has been taken off the screen, the selected region will be enlarged to fill the entire graph window display.


## Quick

There are six of these commands：
Quick Trig
Quick $\log (\mathrm{x})$
Quick $\mathrm{e}^{\wedge} \mathrm{x}$
Quick x＾2
Quick－ $\mathrm{x}^{\wedge} 2$
Quick Standard
These quick zoom commands will redraw the graph using preset built－in View Window parameters．


## 2．8 Scrolling and panning the graph view window

Scrolling the graph view window
Once a graph has been sketched，it can be scrolled left，right，up or down using the cursor key or the graph controller arrows．


## Note

The graph controller arrows will only be visible if the Graph Format settings are set with the G－Controller box ticked．

| \％File Edit Type＊ |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Variable Manager View Window |  |  |  | ｜ $\mid$｜ $\mid$｜${ }^{\text {a }}$ |  |
|  |  |  |  |  |  |
| Basic Format |  |  | Sheet | 4 Shee |  |
| Graph Format |  |  | 14 |  |  |
| Geometry Format Advanced Format Financial Format Default Setup |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
| Window |  |  |  |  |  |
| Keyboard |  |  |  |  |  |
| Close |  |  |  |  |  |
|  | Line | 픔 | $\sqrt{\square}$ | $\pi$ | $\Rightarrow$ |
| Math2 | $\square^{\square}$ | $e^{\square}$ | ln | $\log _{\square}$ | $\sqrt{\square}$ |
| Math3 | － | $\mathrm{x}^{2}$ | $\mathrm{x}^{-1}$ | $\log _{10}(1)$ | solve（ |
| Trig | － 1 | toDMS | 绐 | \｛ \} | （） |
| Var | sin | cos | tan | － | r |
| abc |  |  |  |  |  |
| V | $\leftarrow$ | 既 | 霜 | ans | EXE |
| Rad R | eal |  |  |  | 血 |



Panning the graph view window
To operate this function, the graph view window needs to be active. Panning is always on, so position your finger (or the stylus) on the graph view window, and drag the window to an appropriate location. Once removed, the graph will be redrawn at that particular location.

### 2.9 Plotting functions using parameters

Let $f(x)=a(x-b)^{2}+c$, where $a, b$ and $c$ are integers.

How is the function $f(x)=x^{2}$ transformed under the following conditions?
a) $a=1, b=0$ and $c$ varies b) $a=1, b$ varies and $c=0$ c) $a$ varies, $b=0$ and $c=1$

Method:
a. Key the following into y l :

$$
1(x-0)^{2}+\{-2,-1,0,1,2\}
$$

Use the Math1 soft keyboard and tap $\}$ to enter the parameter list.
b. Key the following into y 2: $1(x-\{-2,-1,0,1,2\})^{2}+0$
c. Key the following into $y 3$ :

$$
\{-2,-1,0,1,2\}(x-0)^{2}+1
$$

You could also define a list as a variable in the Main application and use that variable.


### 2.10 Graphing an inequality



It is always good practice to check the Settings of the Graph Format before undertaking any graphing activities.

When graphing inequalities, make sure Inequality Plot is set to Intersection.

Sketch $y \leq 2 x+1$.
Method:
Tap $\nabla$ next to $y=$ on the tool bar and select the appropriate type of graph.

Key in the inequality and ensure the box is checked.

Tap $\qquad$ to graph the region.


Sketch the region bounded by the following:

- $y \leq 2 x+1$
- $y>3-x$
- $x \geq 0$
- $y \geq 0$.




### 2.11 Graph functions defined in terms of other functions

Sketch $f(x)=x^{2}$.
Explain graphically, the outcome of the following transformations
a. $-f(x)$
b. $f(x)+2$
c. $2 f(x)$
d. $f(x-4)$

In the
 application tap Define on the Math3 soft keyboard.
Key in the function and press EXE.
Be sure to use a text $f$, not a variable $f$.


Launch the
application. Make y1 be $\mathrm{f}(\mathrm{x})$. Press EXE after each entry.

Tap $\forall$ to graph the function. Functions can be sketched simultaneously or individually, depending on whether the check box is ticked.

You can also specify the graph line style. Simply tap the line style next to the function and the Style Settings window will appear. Select your desired type

 and press $O K$.

Alternative method.
Make y1 $=x^{2}$.
Then define the remaining functions in terms of $\mathrm{y} 1(\mathrm{x})$.

Be sure to use a text $y$, not a variable $y$.


### 2.12 Draw the inverse of a function

Sketch $f(x)=x^{2}$ and its inverse.
Method:
Enter the function into $y \mathbf{l}$. Press EXE].

Select the Analysis option, tap Sketch followed by Inverse.

The inverse of the function will automatically appear in the Graph View Window.

The inverse function will also be
 displayed in the message box.

## Alternative method:

Key the function into the Main application window. Highlight the function and the select Interactive on the menu bar; tap Assistant, followed by invert.

Check the variables in the invert window and press 0 K .

The function and its inverse of the function will appear on the right hand side of the screen (work area).



This can be sketched if required, by opening a graph view window. (Tap $\psi$ on the tool bat.) Select each in turn and "drag and drop" them into the graph view window.


## 2．13 Restrict the domain of a function

Sketch $y=x$ ，where $x \geq 0$ ．
Key in the function，using the ＂for＂operator， 1 ，on the Math3 soft keyboard followed by the restricted domain．


Sketch $y=x$ ，where $-2<x<2$ ．

| © File Edit Type＊ |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| W 國 | y＝ | $\checkmark$ |  | ｜ $\mid$｜ $\mid$｜$\left.\right\|^{\prime}$ |  |
| $y 1=x \mid-2<x<2$y2：y3：y4：$\square$y5：y6：y7：口 |  |  |  |  |  |
| Math1 | Line | 틈 | $\sqrt{\square}$ | $\pi$ | $\Rightarrow$ |
| Math2 | Define | $f$ | g | $i$ | $\infty$ |
| Math3 | solve（ | dSlv | ， | \｛吅， | I |
| Trig | ＜ | ＞ | （） | \｛ \} | ［］ |
| Var |  |  |  |  |  |
| abc | $\leq$ | $\geq$ | ＝ | \＃ | $<$ |
| V | 4 | 嫑 | 品 | ans | EXE |
| Rad Real｜而 |  |  |  |  |  |



Note that the＂for＂，$\square$ ，can be used in conjunction with the solve command to find solutions to an equation on a given domain．

### 2.14 Graphing hybrid (mixed or piecewise) functions

Sketch the graph of
$f(x)=\left\{\begin{array}{l}(x+2)^{2}, x \leq-2 \\ x+2,-2<x<0 \\ x, x \geq 0\end{array}\right.$
Key in the function, then the "with" operator, I , followed by the restricted domain. (This can be found on the Math3 soft keyboard, as are the inequality operators.)

Tap $\#$ on the tool bat.



An alternative way to plot a piecewise function is to use the [迨 template that can be found on the Math3 soft keyboard.


### 2.15 Graphing reciprocal functions

Sketch the graph of $f(x)=x+1$ and the reciprocal function, $\frac{1}{f(x)}$.

Key in the function into $y l$ and the reciprocal function into $y$ 己. Tap $\forall$ on the tool bat.

Alternatively, the function $f(x)=x+1$ could also be defined in the
 application.
Then go to the Graph \& Table application to graph the



### 2.16 Graphing rational functions

Sketch the graph of
$f(x)=\frac{x^{2}-5 x+6}{x-4}$, showing axis intercepts and asymptotes.
Key in the function into $y \mathbf{l}$.
Tap $\#$ on the tool bat.
Check your graph view window settings by tapping [f] located on the tool bat. If necessary, change your window settings, and then tap $O K$.

Alternatively, you can use the Zoom commands to resize the graph view.


Use the Table function to help you find any asymptotes. Select 匪国 on the tool bar. This will generate a table of values and will be displayed in a Table window.


### 2.17 Graphing sum and difference functions

Sketch the graph of $y=x+\frac{1}{x}$.
To sketch the graph of the sum (or difference) function, the individual functions are sketched onto the same set of axes. Using the method of addition of ordinates, the sum (or difference) function can then also be sketched.

Key in the sum (or difference) function into $y l$.
$y$ z $=x$
$y^{3}=\frac{1}{x}$


Use the Table function to help you use the method of addition of ordinates．Select 驅閏 on the tool bat．

This will generate a table of values and will be displayed in a
Table window．By adding the $y$－coordinates of y 2 and y 3 will give the $y$－coordinate value of the sum function，in this case $y l$ ．

Graph（and view the table of）all three functions to check your answers．


## 2．18 Graphing absolute value（modulus）functions

Sketch the graph of $y=|2 \sin 2 x|$ on the domain $[0,2 \pi]$ ．

Key in the function，using
absolute value（M）（Math2）soft keyboard）then the＂with＂
operator，I ，（Math3 soft keyboard and inequality operators）followed by the restricted domain．


Check your graph view window settings by tapping 挴诸 located on the tool bar．If necessary， change your window settings，and then tap $0 K$ ．

Alternatively，you can use the Zoom commands to resize the graph view．



## 2．19 Graphing product functions

Sketch the graphs of
i）$f(x)=x$
ii）$g(x)=\sin x$
iii）$f(x) g(x)$ ．
Check your graph view window settings by tapping 屋别 located on the tool bar．If necessary， change your window settings，and then tap $0 K$ ．

Alternatively，you can use the Zoom commands to resize the graph view．



Use the Table function to help you．Select 匪倳 on the tool bat．

This will generate a table of values and will be displayed in a Table window．By multiplying the $y$－coordinates of $y l$ and $y z$ will give the $y$－coordinate value of the product function，in this case $y 3$.

Graph（and view the table of）all three functions to check your answers．


## 2．20 Graphing composite functions

For the functions $f(x)=\sin x$ and $g(x)=\sqrt{x}$ ：
Sketch and state the domain of

$$
\text { i) } f(g(x))
$$

$$
\text { ii) } g(f(x))
$$

Define the functions first in the Main application．This way you can easily key in calculations and／or graph the functions．

Use the Table function to help you visualise the domain．


Check your graph view window settings by tapping 居式 located on the tool bat. If necessary, change your window settings, and then tap $O K$.

Alternatively, you can use the Zoom commands to resize the graph view.


## 3. Statistics with the spreadsheet application

### 3.1 Mean, SD (and quartiles)

A company owns a chain of supermarkets Australia-wide. They evaluate three different types of advertising:
Type 1: no advertising
Type 2: weekly advert in the local newspaper
Type 3: Type 2 plus a weekly letter box drop
Forty-two supermarkets are chosen to take part and fourteen are randomly assigned to try out each type. The table below gives the gross turnover (thousands of $\$$ ) for each supermarket in the month during which the types of advertising were used.

Type 1: 232, 243, 255, 256, 263, 264, 265, 265, 270, 273, 274, 282, 282, 295.
Type 2: 253, 255, 261, 264, 274, 275, 289, 289, 289, 292, 292, 304, 307, 310.
Type 3: 252, 263, 271, 272, 283, 284, 290, 293, 295, 298, 299, 299, 304, 309.
Complete the table below.

|  | Type 1 | Type 2 | Type 3 |
| :---: | :---: | :---: | :---: |
| mean $(\bar{x})$ |  |  |  |
| standard deviation (s) |  |  |  |
| minimum | 232 | 253 |  |
| quartile 1 | 256 | 264 |  |
| median | 265 | 289 |  |
| quartile 3 | 274 | 292 |  |
| maximum | 295 | 310 |  |


If data is already present, from the File menu choose New and tap OK.

We will only enter the data for Type 3 in our demonstration. Enter each value in column A.

Tap on the heading of column A to select all cells in column A.
From the Calc menu choose One-Variable.



A second scrollable window (bottom half of screen) will appear and in that will be the summary statistics of the data in column
 summary statistics full screen.

The sample mean is labelled $\bar{x}$.
The sample standard deviation is labelled $s_{x}$.
Scroll down to see other summary statistics. The summary statistics can be pasted into the spreadsheet.

The spreadsheet can be saved.
To do this, tap Output.


You can then choose where to paste these into the spreadsheet. The defaults will locate empty cells for pasting. Tap Paste. All the summary statistics are pasted into the spreadsheet.


You can now complete the fourth column (Type 3) in the table given in the question. Note you could bave calculated the quartiles without the ClassPad in this example.


From the File menu choose Save.


Tap 圈 to create a new folder.


Tap in the name SSheet. I plan to save more spreadsheets into this folder.

Tap OK.


Now to save the file into the folder SSheet, first select SSheet by tapping on it and then type in the file name super.

## Tap Save.

To open the file at a later date, simply launch the Spreadsheet application and from the File menu choose Open.
To open the SSheet folder, tap the small black arrow Select the file and Open.


### 3.2 Mean and SD using frequency

John is a candle maker and makes a certain type of candle called large scented. On each candle's label he wants to display how long the candle is expected to last. To determine the expected time he burns a sample of 15 candles and records the number of hours each burned for (rounded to the nearest hour). The data is given below.

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


If data is already present, from the File menu choose New, tap OK.

To save time, enter the data as a frequency table. You do not need the headings time and freq.

Note that you could enter each of the 15 values in column $A$ and proceeded without a frequency column. See section 4.1.

Tap on the heading of column A and drag across to the heading of column B to select all cells in column A and B.

From the Calc menu choose One-Variable.


A second scrollable window (bottom half of screen) will appear, and in that will be the summary statistics of the data in
 to view summary statistics full screen.

The sample mean is labelled $\bar{x}$.
The sample standard deviation is labelled $s_{x}$
Scroll down to see other summary statistics. The summary statistics can be pasted into the spreadsheet.

The spreadsheet can be saved.
To do this, tap Output.


You can then choose where to paste these into the spreadsheet. The defaults will locate empty cells for pasting. Tap Paste.

All the summary statistics are pasted into the spreadsheet.


From the File menu choose Save.

| * File Edit Graph Calc |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: |
| ${ }^{0.5} 5$ | New <br> Open | V Gd \|ll| |  |  |
|  | Save | C | D |  |
| 1 |  |  | 101.867 |  |
| 2 | Export |  | 1528 |  |
| 3 | Export |  | 155858 |  |
| 4 | Recalculate |  | 3.70345 |  |

Now to save the file into the folder SSheet, first select SSheet by tapping on it and then tap in the file name candle.

Tap Save.

To open the file at a later date, simply launch the Spreadsheet application and from the File menu choose Open and proceed. To open the SSheet folder, tap the small black arrow. Select the file and Open.


### 3.3 Least squares regression line

1948 was the first year that General Motors Holden (GMH) made the first Holden (aka the Humpy or 48-215 or FX). Prior to that GMH assembled other car brands. From 1948 onwards, the number of non-Holden cars assembled declined as the number of Holden cars made increased.


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

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

a) Using $N$ as the independent variable, find the equation of the least squares regression line.
b) Determine the size of the residual for 1953 and interpret this value.
c) Use the equation to predict how many non-Holden cars would have been made, if the trend seen above continued, in 1974.

Tap the icon to launch the application.

If data is already present, from the File menu choose New, tap OK.

Enter the data as seen opposite.
Tap on the heading of column A and drag across to the heading of column B to select all cells in column A and B.

From the chart wizard $(\sqrt{\mathbf{v}})$ tap to make a scatter plot.


To calculate the equation of the least squares regression line, tap $\bigsqcup_{x}$.
You can see below that the line is drawn on the scatter plot and the details of the line are given in a scrollable window.

- a - slope of the least squares regression line
- $\quad b-y$-intercept of the least squares regression line
- $r$ - Pearson's product-moment correlation coefficient
- $r^{2}$ - coefficient of determination.

Tap Output to paste the details into the spreadsheet (tick Residuals) and then tap Paste and then Close.


So the equation required is: $N=-1.06 \times$ year +24.77
Cell E6 displays the residual for 1953, -3.99 , so approximately 4000 less non-Holden cars were assembled than predicted by the model.

| \% File Edit Graph Calc |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| ${ }^{0.5}$ | B | A | 邫 1.6 | Gd $\because \because \cdot$ | v - |
|  |  | C | D | E | 4 |
| 1 | a |  | -1.0633 | 1.49359 |  |
| 1 | b |  | 24.7697 | 7-0.4431 |  |
| 3 | r |  | -0.8259 | 92.32016 |  |
| 4 | $\mathrm{r}^{2}$ |  | 0.68214 | -0.2166 |  |
| 5 I | MSe |  | 7.5336 | 1.0500 |  |
| 6 |  |  |  | -3.9900 |  |
| 7 |  |  |  | $1{ }_{1} 07001$ |  |
| 8 |  |  |  | 4.33660 |  |
| 9 |  |  |  | -0.1001 |  |
| 10 |  |  |  | -3.2368 |  |
| 11 |  |  |  | 0.72646 |  |
| 12 |  |  |  | 1.18974 |  |
| 13 |  |  |  |  |  |
| 14 |  |  |  |  |  |
| 15 |  |  |  |  |  |
| 16 |  |  |  |  | $\nabla$ |
| 4 |  |  |  |  | $\checkmark$ |
| 1.493589744 |  |  |  | $\checkmark$ | \| $\times$ |
| E1:E12 |  |  |  |  | 四 |

We can calculate the predicted number of non-Holden cars assembled in 1974 (year 27) in the spreadsheet.
Click on C8 and enter 27 and press EXE.
Then, in cell C9 enter the formula =D1×C8+D2 and press EXE. (Note that you can tap on the cells to enter them as part of a formula.)


So the model predicts a negative number of cars (actually 6000 were assembled).

Save this spreadsheet for potential use at a later point.

## Note:

You can now change the value in cell C8 (then press EXE) and the predicted value in C9 will automatically be recalculated.


### 3.4 Transforming to linear

The current study design requires that you know how to use the square, $\log$ and reciprocal transformation. In this book we illustrate the log transformation. The other two can be carried out in an equivalent manner using the ClassPad.

Following on from the previous section, the table below shows the number of Holden cars ( $N$ thousands) assembled in each year from 1950 to 1958. In the table, year 3 represents 1950.

| year | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $N$ | 20.8 | 25.4 | 32.8 | 44.5 | 54.7 | 63.3 | 70.2 | 95.6 | 111.3 |


a) Apply a $\log N$ transformation to linearise this scatter plot. Determine the equation of the least squares regression line for the linearised data.
b) Use your answer to part (a) to predict the number of Holden cars made in 1970.

Tap the
 icon to launch the application.

If data is already present, from the File menu choose New, and tap OK.

Enter the data as seen opposite using columns A and B. In cell C1 put the heading $\log N$.
Press Keyboard.
In cell C 2 enter the formula $=\log _{10}(\mathrm{~B} 2)$ and then press EXE


We now need to copy the formula entered in C2 and paste it into the range of cells C3：C10．
To do this，select cell B2 and then tap Edit（menu bat），Fill and then Fill Range．
Enter the Range to be filled．Tap OK．


| ${ }^{0.5}$ | B［fdx |  | Gd［ $\because \therefore$ | － |
| :---: | :---: | :---: | :---: | :---: |
|  | A | B | C | 4 |
| 1 | year | N | $\log \mathrm{N}$ |  |
| 2 | 3 | 20.8 | 81.31806 |  |
| 3 | 4 | 25.4 | 41.40483 |  |
| 4 | 5 | 32.8 | 81.51587 |  |
| 5 | 6 | 44.5 | 51.64836 |  |
| 6 | 7 | 54.7 | 71.73799 |  |
| 7 | 8 | 63.3 | 31.80140 |  |
| 8 | 9 | 70.2 | 21.84634 |  |
| 9 | 10 | 95.6 | 61．98046 |  |
| 10 | 11 | 111.3 | 32.04650 |  |
| 11 |  |  |  |  |
| 12 |  |  |  |  |
| 13 |  |  |  |  |
| 14 |  |  |  |  |
| 15 |  |  |  |  |
| 16 |  |  |  | F |
| 4 |  |  | $\stackrel{\rightharpoonup}{1}$ |  |
| $=\log$ | （10，B2） |  | $\checkmark$ | X |
| C2 1.3 | 318063335 |  |  | 四 |

Alternatively，you could have used the Copy and Paste features．These exist in both the menu bar under Edit OR on the soft keyboards（Copy＝酋；Paste＝㽬．

Now select all cells in columns A and C by tapping on the A at the top of column A and at the top of column C．



To calculate the equation of the least squares regression line, tap $\boxed{Z}_{x}$.
So the equation required is: $\log _{10} N=0.09 \times$ year +1.06
Tap Output to paste the details (including the residuals into the spreadsheet.
In cells D7, 8 and 9 we have calculated the predicted number of cars manufactured in 1970 (year 23). About 1.4 million! Actually, about 200,000 were manufactured that year.


| ${ }_{\square}^{0.5}$ | B A |  | Gd [ $\because \because$ | - |
| :---: | :---: | :---: | :---: | :---: |
|  | D | E | F | 4 |
| 1 | a | 0.09091 | 1-0.0183 |  |
| 2 | b | 1.06361 | 1-0.0224 |  |
| 3 | r | 0.99445 | -2.3E-3 |  |
| 4 | $\mathrm{r}^{2}$ | 0.98893 | 30.03929 |  |
| 5 | MSe | $7.93 \mathrm{E}-4$ | 40.03801 |  |
| 6 |  |  | 0.01052 |  |
| 7 | 23 |  | -0.0355 |  |
| 8 | 3.15453 |  | $7.75 \mathrm{E}-3$ |  |
| 9 | 1427.35 |  | -0.0171 |  |
| 10 | $\cdots$ |  |  |  |
| 11 |  |  |  |  |
| 12 |  |  |  |  |
| 13 |  |  |  |  |
| 14 |  |  |  |  |
| 15 |  |  |  |  |
| 16 |  |  |  | $\nabla$ |
| 4 |  |  | - |  |
| $=10$ | ^D8 |  | $\checkmark$ | $\times$ |
| D9 14 | 27.35204 |  |  | 孟 |

Save your spreadsheet for use at another time.

### 3.5 Three-median smoothing

The following process offers a very efficient and accurate method to calculate all values associated with three-median smoothing, potentially saving time in the examination. However, this method does not illustrate how the process works, which some exam questions require.

Consider the following data and the graph of $P$ vs $t$.

| $t$ | 24 | 28 | 45 | 53 | 68 | 75 | 82 | 94 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $P$ | 130 | 155 | 150 | 280 | 345 | 398 | 410 | 500 |



Calculate each smoothed data point for this time series if three-median smoothing is used.

Tap the $\qquad$ sheet icon to launch the application.

If data is already present, from the File menu choose New, tap OK.
Enter the data as seen below using columns A and B.
It is wise to make a scatter plot to double check you entered the data correctly.
Select the data and from the Calcmenu, Regression, then choose MedMed Line.


The slope and the $y$-intercept of the three-median-fit line are given.

Tap Output and then Paste as you have been shown in earlier sections.


In calculating the slope and intercept, the ClassPad also calculates and stores the tbree-median points used in the calculation.
To display the values, press Keyboard and from the Catalog ue tab locate the commands starting with 'me', specifically medx 1 and so on.
In cell C4 enter the formula $=$ medx $x_{1}$ (use the INPUT button)
In D4 enter $=$ medy $_{1}$ and so on to display the three-median points.


The real value of this spreadsheet is having it built and saved before the exam so that you can just enter the data, fit the line and display the results.
Save the spreadsheet and call it threemed.

## Caution

1. Be sure not to leave any data points from the previous problems in columns A and B. Select the cells and from the Edit menu choose Cut to clear the cells.
2. The pasted values of $a$ and $b$ will not update when a new fit is calculated, remove them before calculating the new fit.
3. The display of the three-median points will NOT automatically update when a new fit is calculated. Do not Cut them though, rather from the $\mathrm{Fi} l \mathrm{l}$ menu choose Recalculate to ensure the new values are displayed.


### 3.6 Moving average smoothing

The following process offers a very efficient and accurate method to carry out all the calculations required with this process which will potentially save time in the exam.

The following table displays the share prices for a given company on the first 12 days of February.

| Date (Feb.) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| :--- | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Price (AUD) | 2.40 | 2.55 | 2.50 | 2.60 | 2.79 | 2.65 | 2.55 | 2.60 | 2.59 | 2.65 | 2.65 | 2.55 |

Find the smoothed value for February 5 using four point moving average smoothing, with centering.

Tap the $\square$ icon to launch the application.

If data is already present, from the File menu choose New, tap OK.
To calculate this value we need the data point for Feb 5 and two points on either side of it, 5 in total.

Enter the 5 data points in columns A and B as shown below. Drag the dividing lines in between the column headers to narrow the columns so you can see columns A to D.
In cell C 2 enter the formula $=\operatorname{sum}(\mathrm{B} 1: \mathrm{B} 4) / 4$
[the range can be entered by dragging across the cells].
In cell C4 enter the formula $=$ sum(B2:B5)/4.
In cell D3 enter the formula $=(\mathrm{C} 2+\mathrm{C} 4) / 2$.


The smoothed price for Feb 5-\$2.64. Save it as fourmean.
The real value in this spreadsheet is that you can nows save it and have it ready for the exam question that may come. You can then simply type in the five values and all the other cells will update automatically.

## Suggestion

You might like to make similar spreadsheets (and save them) for the calculations involved with:

- the 3 point moving average
- seasonal indices.

They might improve accuracy and save time in the exam.

## 4. Calculus

### 4.1 Limits

Find a) $\lim _{x \rightarrow \infty}\left(\frac{1}{x}\right)$
b) $\lim _{x \rightarrow 0^{+}}\left(\frac{1}{x}\right)$
c) $\lim _{x \rightarrow 0^{-}}\left(\frac{1}{x}\right)$

In the

application key in the limit statement, using the limit
template, ${ }_{\text {lim }}^{\square \rightarrow-a}$, on the Math2 soft keyboard.

To enter the direction of the limit, use the + and - operators available on the abc soft keyboard, tap Math tab to view/select. (Note: you can also use the standard + and operators.)


Alternatively, the limit statement could be entered using the lim option in the Calculation sub-menu of Interactive.

The lim dialogue box allows you to check/enter details regarding the limit statement.


Note that the Direction input can be - 1 ifyou want the limit approaching from the left, 1 for the right and 0 for both.

### 4.2 Rates of Change

### 4.2.1 Average rates of change

Calculate the average rate of change for
$f(x)=x^{2}+2 x+2$ on the intervals:
a. $\quad x=3$ and $x=3.1$
b. $x=3$ and $x=3.05$
c. $x=3$ and $x=3.001$
d. $x=3$ and $x=3+h$

Define the function, press EXE.
Calculations can be easily performed by selecting the previous input, dragging and dropping it into the next working
 line and then editing it.

### 4.2.2 Instantaneous rates of change

Calculate the instantaneous rate of change where $f(x)=x^{2}+2 x+2$ at $x=3$.

To find the instantaneous rate of change, find the limit (as $h$ approaches 0 ) of the average rate of change for the interval $[3,3+h]$.
Define the function, press EXE.
Key in the function, using the limit feature, ${ }_{l i m}{ }^{-1 i m}$, on the Math2 soft keyboard.


## 4．3 Derivatives

Find
a．the derivative of

$$
f(x)=x^{2}+2 x+2
$$

b．$f^{\prime}(2)$
c．$f^{\prime}(-3)$

Define the function，press EXE．
Key in the problem，using the derivative feature，$\frac{d}{d a b}$ ，on the Math2 soft keyboard．Use the ＂for＂operator，$\quad 1$ ，followed by the condition．


| \％Edit Action Interactive |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| 0.5 <br> 4 <br> 4 | $\cdots$ | Simp | $\xrightarrow{\text { fax }}$ ） |  | V |
|  |  |  |  |  | one $\triangle$ |
| $\left.\frac{\mathrm{d}}{\mathrm{~d} x}(\mathrm{f}(x)) \right\rvert\, x=2$ |  |  |  |  |  |
| $\left.\frac{\mathrm{d}}{\mathrm{~d} x}(\mathrm{f}(x)) \right\rvert\, x=-3$ |  |  |  |  |  |
| $\square$ |  |  |  |  |  |
|  |  |  |  |  |  |
| Math1 | Line | 듬 | $\sqrt{\square}$ | $\pi$ | $\Rightarrow$ |
| Math2 | Define | $f$ | g |  |  |
| Math3 | Solve（ | dSlv |  | \｛ ${ }^{\text {C }}$ | 1 |
| Yar | ＜ | ＞ | （） |  | 1 |
| abc | $\leq$ | $\geq$ | ＝ | \＃ | $\angle$ |
| － | 4 | 暨 | 賈 | ans | EXE |
| Alg | Decimal |  | Real | Rad | 四 |

Alternative method：
Key in and select the function．
Tap Interactive，then Calculation，followed diff．

Select Derivative at value．Enter variable，order and value into the $\operatorname{diff}$ dialogue box．Tap OK．

This feature helps you to use syntax to solve the task．

| \％Edit Action Interactive |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Transformation Advanced |  |  |  |
| Define $\mathrm{f}(\mathrm{x})=$ |  | Calcula diff |  |  |  |
|  |  | Complex impDiff |  |  |  |
| $\mathrm{f}(\mathrm{x})$ |  | $\begin{array}{\|l\|l} \hline \text { List } & \mathcal{S}^{2} \\ \text { Matrix } & \text { lim } \end{array}$ |  |  |  |
|  |  |  |  |  |  |
|  |  | Vector |  |  |  |
|  |  | Equatio П |  |  |  |
|  |  | Assista rangeAppoDistribu mod |  |  |  |
|  |  |  |  |  |  |
|  |  | Financia line |  |  |  |
| Math1 | Line | Define fM |  | Min／fMax |  |
| Math2 | $\square^{\square}$ | $e^{\square}$ | $\mathrm{gcd} / \mathrm{lcm}$ |  |  |
| Math3 |  |  | $\frac{\text { fraction }}{\mathrm{x}-10 \mathrm{Bran}(\mathrm{T})}$ |  |  |
|  | $\square$ | $\mathrm{x}^{2}$ |  |  | sul |
| Trig | 10 | toDMS | \｛昌 | \｛ \} | （） |
| Var | sin | $\cos$ | tan | 。 | r |
| abc |  |  |  |  |  |
| V | 4 | 暨 | C | ans | EXE |
| Alg | Standard |  | Real | Rad | tim |


| diff |  |  |  |  | x |
| :---: | :---: | :---: | :---: | :---: | :---: |
| nifforemtiotion  <br> Derivative at value  <br> Expresion：  <br> Variable：  <br> Order：  <br> Value：  <br> Y  1 |  |  |  |  |  |
| 10 OK |  |  |  | Cancel |  |
| Math1 Line |  |  |  |  |  |
| Math2 | $\square^{\square}$ | ${ }^{\text {■ }}$ | ln | $\log _{\text {® }}$ | $\sqrt{\square}$ |
| Math3 | － | $\mathrm{x}^{2}$ | $\mathrm{x}^{-1}$ | $\log _{10}(\mathrm{I})$ | solve（ |
| Trig | －10］ | toDMS | \｛吕 | \｛ \} | （） |
| Var | $\sin$ | cos | tan | ${ }^{\circ}$ | r |
| abc |  |  |  |  |  |
| － | 4 | 饟 | 肂 | ans | EXE |
| Alg | Stand |  | Real | Rad | tim |




Using the 掣 Graphs application，find $f^{\prime}(2)$ where $f(x)=x^{2}+2 x+2$ ．
In this example the function has been defined $\mathrm{f}(x)$ in the Main application

Key in the function as $\mathrm{f}(x)$ into the graph editor window．Press EXEs．

Tap $\forall$ to graph．

Tap then Graph Format． Make sure Derivative／Slope is ticked．Tap Set．


With the graph view window active，tap Analysis，then Trace．

Press $\qquad$ 2．The Enter Value box will appear．Tap OK．

The derivative at $x=2$ ，along with the coordinates of the function will be displayed in the graph window．




### 4.3.1 Sketching the derivative function

Sketch $f(x)=x^{2}+2 x+2$ and its derivative $f^{\prime}(x)$.

In this example the function has been defined and stored as $\mathrm{f}(x)$.

Key in the function as $\mathrm{f}(x)$ into the graph editor window. Press EXE.

Key in the derivative function, using the derivative template,

> Math2 soft keyboard. Press EXE.



Tap $\#$ to graph.

### 4.3.2 Sign of the derivative

How do I calculate when a derivative is negative / positive / zero?

Find when the derivative of $y=4 x^{3}+27 x^{2}-30 x+10$ is negative.

In the $\sqrt{\sqrt{\alpha} \text { main }}$ application, find an expression for the derivative function.

Tap to show the graph view window.
'Drag and drop' function in the graph view window. The graph of the function will automatically appear in this window. Adjust view window as required.

We can now see when the derivative is less than zero.


Select the derivative and drag it to an empty input box．

Set the derivative to be $\square<$ ， using the Math3 keyboard．

Select the inequality．
Tap Interactive， then Equation，
then solve，
then OK．

| \％Edit Action Interactive |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  |  |  |  |  |
| $\begin{array}{r} \frac{\mathrm{d}}{\mathrm{~d} x}\left(4 x^{3}+27 x^{2}-30 x+10\right) \\ 12 \cdot \mathrm{x}^{2}+54 \cdot x-30 \\ \text { solve }\left(12 \cdot \mathrm{x}^{2}+54 \cdot x-30<0, \mathrm{x}\right) \\ \left\{-5<\mathrm{x}<\frac{1}{2}\right\} \end{array}$ |  |  |  |  |  |
| $\square$ |  |  |  |  |  |
| Math1 | Line | 晒 | $\sqrt{\square}$ | $\pi$ | $\Rightarrow$ |
| Math2 | Define | f | g | $i$ | $\infty$ |
| Math3 | solve（ | dSlv |  | \｛吅吅 | 1 |
| Trig | ＜ | ＞ | （） | \｛ \} | ［］ |
| Var |  |  |  |  |  |
| abc | $\leq$ | $\geq$ | ＝ | \＃ | $<$ |
| － | － | 艮詈 | 䠝 | ans | EXE |
| Alg | Standa |  | Real | Rad | 四 |

## 4．3．3 Tangent and normal to a curve

Sketch $f(x)=x^{2}+2 x+2$ the tangent and normal at $x=-2$ ． Find the equation of the tangent and normal．

In this example the function has been previously defined as $\mathrm{f}(x)$ in the Main application．

Key in the function into the graph editor window．Press EXE．Tap $\forall$ to graph． With the graph view window active，tap Analysis，then Sketch，followed by
 Tangent．

Enter－ 2 and the Enter
Value box will appear．Tap OK．
Crosshairs will appear at that point．You must press EXE in order for the tangent to appear．

The tangent at that point，along with the coordinates of the function will be displayed in the graph view window．


The equation of the tangent appears in the message box．

To find the normal at that point, make the graph view window active, tap Analysis, then Sketch, followed by Normal.

Enter - 2 and the Enter
Value box will appear. Tap OK.
Crosshairs will appear at that point. You must press EXE for the normal equation to appear.

The normal at that point, along with the coordinates of the function will be displayed in the graph view window.


The equation of the normal appears in the message box.

### 4.4 Integration

### 4.4.1 Indefinite integrals

Find the integral of
$f(x)=10 x^{4}+6 x^{3}+2$.
In the Main application, key in the calculation, using the integral feature, $f_{\square}^{\text {a }}$, on the Math2 soft keyboard.

Note: Do not enter lower \& upper terminals for indefinite integrals.


When working with indefinite integrals, don't forget you will need to include the constant of integration, $c$, when writing down your answer.

Alternative method:
Key in and select the function.
Tap Interactive, then Calculation, followed by $\int$ (the integral sign).

## Select Indefinite

integral. Enter the variable you are integrating with respect to into the variable box. Tap $\triangle K$.

The answer will appear on screen.


## 4．4．2 Definite integrals（without a graphical display）

Calculate $\int_{1}^{4} \frac{5}{x}+e^{\frac{x}{2}} d x$ ．
Key in the function，using the integral feature，flat ，on the Math2 soft keyboard．

Note：Don＇t forget to enter lower \＆upper limits for definite integrals．


Alternative method：
Key in and select the function．
Tap Interactive，then Calculation，followed by
$\int$（the integral sign）．
Select Definite integral． Enter the variable you are integrating with respect to，the lower and upper limits into the $\int$ input box．Tap $O K$ ．

Note：This method will provide an＇exact＇result，if possible．


| $f$ |  |  |  |  | $\times$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Definite <br> Expression： <br> Variable： <br> Lower： <br> Upper： |  | Numeric |  |  |  |
|  |  |  |  |  |  |
|  |  | $((5) /(x))+e^{\wedge}$ |  |  |  |
|  |  | x |  |  |  |
|  |  | 1 |  |  |  |
|  |  | 41 |  |  |  |
| OK |  | Cancel |  |  |  |
| Math1 | Line | 듬 | $\sqrt{\square}$ | $\pi \quad \Rightarrow$ |  |
| Math2 | $\square^{\square}$ | $e^{\square}$ | ln | $\log _{\square} \square$ | $\sqrt{\square}$ |
| Math3 | ｜ | $\mathrm{x}^{2}$ | $\mathrm{x}^{-1}$ | $\log _{10}(\mathbb{1})$ | solve（ |
| Trig | － | toDMS | \｛븜 | \｛ \} | （） |
| Var | $\sin$ | $\cos$ | tan | 。 | r |
| abc | $\sin$ |  |  |  |  |
| V | 4 | 霾 | 橧 | ans | EXE |
| Alg | Standard |  | Real | Rad | 四 |



How do I solve for an unknown in an equation involving a definite integral?
Calculate the value of $b$ if
$\int_{b}^{1} \frac{7}{x} d x=7$.
Launch the
 application.

Use the Math2 keyboard to enter f

You will need the Yar keyboard to enter the $b$.

Complete and select the

| \% Edit Action Interactive |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\left\lvert\, \begin{aligned} & \text { ddx } \\ & \text { dxa }\end{aligned}\right.$ | Sim | ddx | V | U | V |  |
| $\int_{b}^{1} \frac{7}{x} \mathrm{~d} x=7$ |  |  |  |  |  |  |  |
| Math1 | $a$ | $b$ | c | $d$ | $e$ | $f$ |  |
| Math2 | $g$ | $h$ | $i$ | $j$ | $k$ | $l$ |  |
| Math3 | $m$ | $n$ | $o$ | $p$ | $q$ | $r$ |  |
|  |  | $t$ | $u$ | $v$ | w | $x$ |  |
|  |  | $z$ |  |  |  | caps |  |
| V | - | 暨 | - |  | ans | EXE |  |
| Alg | Standard |  | Real | R | Rad |  | 血 |

## Note:

After entering the $x$ in $\mathrm{d} x$, press
(right cursor key) to ensure the cursor is flashing alongside the whole integral expression (not just the dx ) before entering the ' $=7$ '. equation.

Tap Interactive, Equation/Inequality, then solve.

Change the variable to be solved for to $b$, using the Var keyboard.

Tap OK.


Two solutions, in exact form are provided.

It may be that only one of the solutions is suitable, depending on the requirements of the question you are answering.


### 4.4.3 Definite integrals (with a graphical display)

Using the 四皿 $_{\substack{\text { Grabhs } \\ \text { Table }}}^{\text {application, }}$ compute the value of $\int_{1}^{4} \frac{5}{x}+e^{\frac{x}{2}} d x$ and display an interpretation of it.

Key the function into the graph editor window. Press EXE. Tap $\square$ to graph.

With the graph view window active, tap Analysis, then G-Solve, Integral, followed by $\int d x$.


Press 1 and the Enter Value box will appear. Key in the lower and upper intervals and tap OK.

The function, along with the area interpretation of the integral, will be displayed in the graph view window. The decimal approximation of the integrals value will be displayed at the bottom of the screen.


Note that this method will return a decimal approximation for the integral.

### 4.5 Area bound by a curve and the $x$-axis

Find the area bound by the $x$-axis and the graph of the function, $f(x)=1-x^{2}$.

Define the function in $\sqrt{\alpha}$ Main
Tap $\psi$ to show the graph view window.
'Drag and drop' function in the graph view window. The graph of the function will automatically appear in this window.
 on the tool bar. If necessary, change your window settings, and then tap OK.

Or, you can use the Zoom commands to resize the graph view.


With the graph view window active, tap Analysis, then GSolve, Integral, followed by $\int d x$ Root.

This method uses $x$-intercepts that exist is the view window.

A pink cursor will flash at the Lower $x$-intercept (or use your cursor key to move to the correct lower limit). Press EXE.


The pink cursor will flash waiting for the Upper $x$-intercept , use your cursor key to move to the correct upper limit). Press EXE.

The function, along with the area interpretation of the integral will be displayed in the graph view window. The decimal approximation of the integrals value will be displayed at the bottom of the screen.


The final screen shot also contains the solution to the problem using the Main application. This method uses the sketch to help you determine the $x$-intercepts. It is good practice to use graphs to assist in problems involving the calculation of areas under curves.
It is solved by using the method as shown in Section 5.4.2.

### 4.6 Area between two curves

Find the area enclosed by $f(x)=1-x^{2}$ and $g(x)=1-x$ for the interval $[0,1]$.

## Define the functions in the Main application.

Tap $\forall$ to show the graph view window.
'Drag and drop' functions in the graph view window. The graphs of the functions will automatically appear in this window.

Check your graph view window settings by tapping [植 located on the tool bar. Or, you can use the Zoom commands to resize the graph view.


With the graph view window active, tap Analysis, then G-Solve, Integral, followed by $\int d x$
Intersection.
This method uses intersection points that exist is the view window.

A pink cursor will flash waiting for the Lower intersection point (use your cursor key to move to the correct lower limit). Press EXE.


The pink cursor will flash waiting for the Upper intersection point (or use your cursor key to move to the correct upper limit). Press EXE.

The function, along with the area interpretation of the integral will be displayed in the graph view window. The decimal approximation of the integrals value will be displayed at the bottom of the screen.


The final screen shot also contains the solution to the problem using the Main application. This method uses the sketch to help you determine which function needs to be 'subtracted'. It is good practice to use graphs to assist in problems involving the calculation of areas under curves. It is solved by using the method as shown in Section 5.4.2.

### 4.7 Mean value of a function

Find the mean value of the function $f(x)=6 x^{2}$ over the interval [0, 4].

Use the variable assignment key

$\Rightarrow$, to assign a numerical value to a variable.


By using this method, you can easily change the upper and lower limits and/or the function. Simply "highlight", key in changes and press EXE.

The final answer will appear without having to re-input the integral.


### 4.8 Second derivative

Find $f^{\prime \prime}(x)$ if $f(x)=x^{\frac{5}{2}}+2 \sqrt{x}$
Key in the problem, using the derivative feature, $\frac{\mathrm{d}^{0} 0}{\mathrm{~d} 0}$, on the Math2 soft keyboard.


Alternative method：
Enter the function and highlight．
Tap Interactive，then Calculation，followed diff．

Select differentiation．Enter variable and order（2）into the diff box．Tap OK．

The resultant screen will view as in the previous method．

| \％Edit Action Interactive |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | Transformation Advanced |  |  |  |
| $x^{\frac{5}{2}}+2 \sqrt{x}$ |  | Calcula diff |  |  |  |
|  |  | Comple： impDiff <br> List $S^{2}$ <br> Matrix $\lim$ <br> Vector $\sum$ <br> Equatio $\Pi$ <br> Assista rangeAppoint <br> Distribu mod |  |  |  |
|  |  | Financi Define | is line fMin／fMax |  |  |
| Math1 | Line |  |  |  |  |
| Math2 | $\square^{\square}$ | $e^{\square}$ g |  |  |  |
| Math3 |  | $\frac{\mathrm{d}}{\mathrm{d}}$－ |  |  |  |
|  | － |  | $\frac{\text { fraction }}{\text { di }}$ |  | $\xrightarrow{130}$ |
| ， | ［－1］ | ［ | ［吅］ | 号口 | 品 |
| Var | sin | cos | tan | $\theta$ | $t$ |
| abc |  | 蔇 | ¢ | ans | EXE |
| － | － | 管 |  | ans | EXE |
| Alg | Standa |  |  | Rad | 而 |



## 4．9 Volumes of solids of revolution

Consider the region bounded by the $x$－axis and the given lines for：
$y=\sin x ; x=0$ and $x=\frac{\pi}{2}$ ．
Find the volume of solid of revolution generated when the region is rotated about the $x$－axis．

Define the function in the Main application．

Tap $\forall$ to show the graph view window．
＇Drag and drop＇function in the graph view window．The graph of the function will automatically appear in this window．

With the graph view window active，tap Analysis，then G －Solve，followed by $\pi \int f(x)^{2} d x$ ．


Key in the lower value (press 0) and the Enter Value box will appear. Key in the lower and upper intervals and tap OK.

The function, along with the volume interpretation of the integral will be displayed in the graph view window. The decimal approximation of the volume will be displayed at the bottom of the screen.


The final screen shot also contains the exact solution to the problem using the

## $\sqrt{\alpha}$ Main

It is good practice to use graphs to assist in problems involving the calculation of volumes of revolution.

### 4.10 Direction field for a differential equation


Enter the DE $y^{\prime}=2 y$.
 generated.

## Resize

Tap screen) to have the full screen view.


Now tap $\stackrel{\text { Resize }}{\text { PTV }}$ again and tap the IC (Initial Conditions) tab.

Set some ICs and then tap theagain.

This will plot a path through the slope field, starting at $(0,1)$ in this case.

You can also plot the graph of a function to test your conjecture about the solution to the DE .


Tapping the View Window settings and allows you to set at will. Note the Steps setting.


Note that the Spreadsheet on the ClassPad has CAS capabilities and so making a spreadsheet to display Euler's Method numerically and graphically is quite simple.

An eActivity that does this is available from http://www.casio.edu.shriro.com.au/.

## 5．Matrices

## 5．1 Inputting matrix data

The examples below use the［盶，［0］and［品］keys on the Math2 soft keyboard to enter the matrix using natural input．

| To do this： | Tap this button： |
| :---: | :---: |
| Create a new 1－row x 2－column matrix | ［0］ |
| Create a new 2－row x 1－column matrix | ［日］ |
| Create a new 2－row x 2－column matrix | ［踄］ |
| Add a column to the currently displayed matrix | $\square \square$ |
| Add a row to the currently displayed matrix | ［［0］ |
| Add both a row and column to the currently displayed matrix |  |

Define the following matrices．
$A=\left[\begin{array}{ll}2 & 1 \\ 4 & 3\end{array}\right]$
$B=\left[\begin{array}{ccc}2 & 1 & -1 \\ 0 & -4 & 2\end{array}\right]$
$C=\left[\begin{array}{l}-1 \\ -2 \\ -2\end{array}\right]$
$D=\left[\begin{array}{cc}2 & 1 \\ -1 & 2\end{array}\right]$

Key in the matrix，using the

 $\left[\begin{array}{l}{[\square]}\end{array}\right.$ and $[\square]$ keys on the
Math2 soft keyboard．

## 5．1．1 Matrix calculations

This subsection will use the following exercise to demonstrate matrix calculations using the ClassPad．It assumes you have defined matrices A to D as shown in the previous section．

Given the following matrices：

$$
\begin{array}{ll}
A=\left[\begin{array}{ll}
2 & 1 \\
4 & 3
\end{array}\right] & C=\left[\begin{array}{l}
-1 \\
-2 \\
-2
\end{array}\right] \\
B=\left[\begin{array}{lll}
2 & 1 & -1 \\
0 & -4 & 2
\end{array}\right] & D=\left[\begin{array}{cc}
2 & 1 \\
-1 & 2
\end{array}\right]
\end{array}
$$

Calculate the following：
a）$A+D$
b） $2 A-D$
c）$B C$
d）$A^{2}$
e）$A^{-1}$
f） $\operatorname{det} A$

## Addition

a) $A+D$


## Subtraction

b) $2 A-D$

| \% Edit Action Interactive |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| ${ }^{0.5} \frac{1}{4} \frac{1}{2}$ d | $\int_{\text {da }}^{\text {d }}$ |  | d ${ }^{\text {dx }}$ |  | W | $\checkmark$ |
| $A+D$ |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| $2 A-D$ |  |  |  |  |  |  |
|  |  |  |  |  | $\left[\begin{array}{l}2 \\ 9\end{array}\right.$ | $\left.\begin{array}{l}1 \\ 4\end{array}\right]$ |
| $\square$ |  |  |  |  |  |  |
| Math1 | $A$ | B | C | D | $E$ | $F$ |
| Math2 | G | H | I | $J$ | $K$ | $L$ |
| Math3 | M | $N$ | 0 | $P$ | $Q$ | $R$ |
| Trig | $S$ | $T$ | $U$ | V | W | $X$ |
| Var |  | $Z$ |  |  |  |  |
| abc |  | 2 |  |  |  | caps |
| $\checkmark$ | $\leftarrow$ | 硠 | L |  | ans | EXE |
| Alg | Stand | ard | Real | 1 | Rad | 四 |

## Multiplication

c) $B C$

Note that using the BC from the abc soft key board will not give the result we want. $\mathrm{B} \times \mathrm{C}$ will.
It is good practice to use the letters on the Var soft keyboard - the bold and italic ones that denote a variable.


Computing a given power of a matrix
d）$A^{2}$

| \％Edit Action Interactive |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
|  | $\left[\begin{array}{c}\text { did } \\ \mathrm{dax} \\ \hline 1\end{array}\right.$ | Simp | Sdx | v $\psi$ | V |
| BxC |  |  |  |  |  |
|  |  |  |  |  | －2 4 |
| $A^{2}$ |  |  |  |  |  |
|  |  |  |  | $\left[\begin{array}{ll}8 & 5 \\ 20 & 1\end{array}\right]$ | $\left.\begin{array}{l}5 \\ 13\end{array}\right]$ |
| $\square$ |  |  |  |  |  |
| Math1 | Line | 듬 | $\sqrt{\square}$ | $\pi$ | $\Rightarrow$ |
| Math2 | $\square^{\square}$ | $e^{\prime \prime}$ | ln | $\log ^{\square}$ | $\sqrt{\square}$ |
| Math3 | \｜ | $\mathrm{x}^{2}$ | $\mathrm{x}^{-1}$ | $\log _{10}(\mathrm{I})$ | solve（ |
| Trig | ITI | toDMS | 昭 | \｛ \} | （） |
| Var | sin | cos | tan | 。 | ${ }^{r}$ |
| abc | sin | $\cos$ | tan |  |  |
| V | $\leftarrow$ | 暨 | 䠝 | ans | EXE |
| Alg | Standa | ard | Real | Rad | 而 |

Inverse Matrix
e）$A^{-1}$

| \％Edit Action Interactive |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| ${ }^{0.5} \frac{1}{4} \frac{1}{2}$ d | $\left[\begin{array}{l}\text { dx } \\ \mathrm{dax} \\ \hline\end{array}\right.$ | Simp | $\xrightarrow{\text { Jdx }}$ | －$\psi$ | － |
| $A^{4}$ |  |  |  |  |  |
|  |  |  |  | $\left[\begin{array}{ll}8 & 5 \\ 20 & 1\end{array}\right]$ | $\left.\begin{array}{l} 5 \\ 13 \end{array}\right]$ |
| $A^{-1}$ |  |  |  |  |  |
|  |  |  |  | $\left[\begin{array}{ll}\frac{3}{2} & -\frac{1}{2} \\ -2 & 1\end{array}\right.$ | $\left.\frac{1}{2}\right]$ |
| $\square$ |  |  |  |  |  |
| Math1 | Line | 㫛 | $\sqrt{\square}$ | $\pi$ | $\Rightarrow$ |
| Math2 | $\square^{\square}$ | $e^{\square}$ | ln | $\log _{\text {® }}$ | $\sqrt{\square}$ |
| Math3 | ｜ | $\mathrm{x}^{2}$ | $\mathrm{x}^{-1}$ | $\log _{10}(\mathrm{I})$ | solve（ |
| Trig | －10］ | toDMS | 倡 | \｛ \} | （） |
| Var | sin | cos | tan | 。 | r |
| abc |  |  |  |  |  |
| $\checkmark$ | 4 | 暨 | 電 | ans | EXE |
| Alg | Standa |  | Real | Rad | 血 |

## Determinant

f） $\operatorname{det} A$
Enter $A$ ．
From the menu bar，tap
Interactive，then Matrix， Calculation，followed by det．



### 5.2 Solving simultaneous equations using matrices

Using matrices, solve $3 x-y=10$ and $2 x+5 y=1$.
We can express the simultaneous equations in matrix form:
$\left[\begin{array}{cc}3 & -1 \\ 2 & 5\end{array}\right]\left[\begin{array}{l}x \\ y\end{array}\right]=\left[\begin{array}{c}10 \\ 1\end{array}\right]$
And so $\left[\begin{array}{l}x \\ y\end{array}\right]=A^{-1} \times B$
Enter $\left[\begin{array}{cc}3 & -1 \\ 2 & 5\end{array}\right]$ as $\boldsymbol{A}$ and $\left[\begin{array}{c}10 \\ 1\end{array}\right]$ as $\boldsymbol{B}$ and then compute $A^{-1} \times B$


### 5.3 Geometric transformations using matrices

a) Determine the transformation matrix, $D_{x, y}$, for the combination of transformations: a dilation by a factor of 5 parallel to the $x$ axis followed by a dilation by a factor of 3 parallel to the $y$ axis.
b) Find the coordinates of the transformed image of the point $(7,9)$ under $D_{x, y}$.

Note that we know that each point $(x, y)$ is mapped onto its image $\left(x^{\prime}, y^{\prime}\right)$ by: $\begin{aligned} & x^{\prime}=a x+b y \\ & y^{\prime}=c x+d y\end{aligned}$

Therefore, in matrix form: $\left[\begin{array}{l}x^{\prime} \\ y^{\prime}\end{array}\right]=\left[\begin{array}{ll}a & b \\ c & d\end{array}\right]\left[\begin{array}{l}x \\ y\end{array}\right]$


### 5.4 Transition matrices (Markov chains)

Claude has a coffee shop. He sells coffee and biscotti. He realises that if a person buys (and enjoys) a coffee on a particular day, there is a $75 \%$ probability that the person will return a buy coffee the next day. In addition, if a person buys biscotti one day then there is a $50 \%$ probability that they will purchase biscotti the next day. On Monday, $90 \%$ of Claude's patrons bought coffee and $40 \%$ bought biscotti.
a) Determine a transition matrix, $T$ that models this situation.
b) Determine the initial state matrix, $S_{0}$.
c) What is the probability that a patron will purchase a coffee on Tuesday?
d) What is the probability that a patron will purchase a coffee on Friday?

| - Edit Action Interactive |  |  |
| :---: | :---: | :---: |
| $\cos ^{0.5}$ |  |  |
| $\left[\begin{array}{cc} .75 & .5 \\ .25 & .5 \end{array}\right] \Rightarrow T$ |  |  |
|  | $\left[\begin{array}{ll}0.75 & 0.5 \\ 0.25 & 0.5\end{array}\right]$ |  |
| $\left[\begin{array}{c} .9 \\ .4 \end{array}\right] \Rightarrow S$ |  |  |
|  | $\left[\begin{array}{l}0.9 \\ 0.4\end{array}\right]$ |  |
| $T \times S$ |  |  |
|  | $\left[\begin{array}{l}0.875 \\ 0.425\end{array}\right]$ |  |
| $T^{4} \times S$ |  |  |
| $\left[\begin{array}{l}0.866796875 \\ 0.433203125\end{array}\right]$ |  |  |
| $\square$ |  |  |
| Alg Decimal | Real Rad | , |

## 6．Sequences

Various parts of the
application are shown below．


| Task | Button |
| :---: | :---: |
| Create an ordered pair | 遁 |
| Create an arithmetic sequence table | ${ }_{6}^{\text {b }}$－a |
| Create a geometric sequence table | 发bab |
| Create a progression of difference table | $\mathrm{B}_{6} \mathrm{~b}_{\mathrm{c}}$ |
| Create a Fibonacci sequence table | $\xrightarrow{\substack{\text { c－a } \\ \text { a } \\ \text { a }}}$ |
| Draw a cobweb diagram on a graph | Wx |
| Display the Sequence RUN window |  |
| Specify $a_{n+1} a_{0}$ as the recursion type |  |
| Specify $a_{n+1} a_{1}$ as the recursion type |  |
| Specify $a_{n+2} a_{0} a_{1}$ as the recursion type | （ $\begin{gathered}\text { n＋2 } \\ \text { anaid }\end{gathered}$ |
| Specify $a_{n+2} a_{1} a_{2}$ as the recursion type | ［ ${ }_{\text {a }}^{\text {n＋2 }}$ |
| Input $n$ of a recursion expression | n |
| Delete the recursion expression in the current active line | an ${ }^{\text {\％}}$ |
| Display the Sequence Table Input dialogue box | 敕空 |

## 6．1 Define，tabulate \＆plot a sequence

Consider the sequence
$a_{n}=n^{2}+3 n, n>1$ ．
a）Tabulate the sequence．
b）Plot the sequence．
This is an explicit relationship and so tap the Explicit tab．

Enter the sequence using the n available on the tool bat．Press EXE］．

To create a table for the sequence，tap 革空，to display the Sequence Table Input box．Enter the desired conditions．Tap OK．


Tap 国閏，to display the table．
To plot the sequence，the table window must be active．

Tap to plot．（Or，select Graph，then G－Plot on the menu bar．）
（You may need to alter the View Window settings，tap 臤，to gain a sensible plot．）


### 6.2 Summing of a sequence

Consider the arithmetic series: $13+26+39+\ldots$
a) Find the sum of the first 20 terms.
b) Find the sum of the first $n$ terms.
c) The sum of how many terms first exceeds 4000?

We note that, $a=13, d=13$.
Therefore, $a_{n}=13+13(n-1)$. Open the Main application. Use the Math2 soft keyboard to enter the 國 template.

Using the expression found in part (b), we can set it equal to 4000 and solve for $n$.

Obviously, the solution would be a positive number.


Complete the equation, select the equation and then:
Tap
Interactive menu, then tap Equation/Inequality, and then solve.

Be sure to enter the correct variable, in this case n .


Converting to a decimal approximation ( 25 terms would first exceed 4000.


## 6．3 Difference equations

Consider the sequence defined by the difference equation：
$t_{n+1}=t_{n}+2, t_{0}=1$ ．
a）Find the first seven terms of the sequence．
b）Find the $25^{\text {th }}$ term．
c）Find the sum of the first 5 terms．
d）Plot the sequence．
Select the recursive tab（since this difference equation is a recursive relationship．Use the $a_{n}$ available in the $n, a_{n}$ menu．
Press EXE．
To tabulate the sequence，tap
 Table Input box．Enter the desired conditions．Tap OK．


Tap 匪夙，to display the table．
To plot the sequence，the table window must be active．

Tap to plot．（Or，select Graph，then G－Plot on the menu bar．）
（You may need to alter the View Window settings，tap 䜿伺，to gain a sensible plot．）


## 7. Probability distributions

### 7.1 Discrete probability distributions

### 7.1.1 Finding probabilities, the mean, variance \& standard deviation associated with discrete random variables

As is true in most sections, there are numerous ways to complete the computations outlined in this section. We have chosen methods that keep the user working within the Main application.

Suppose a random variable $X$ has distribution:

| x | 0 | 1 | 2 |
| :--- | :--- | :--- | :--- |
| $\mathrm{p}(\mathrm{x})$ | $\frac{k^{2}}{8}$ | $\frac{4-k^{3}}{8}$ | $\frac{2-k^{2}}{2}$ |

Find the value(s) of $k$ and the values of $p(x)$ in each case.
Define the three elements in the list as a function $p(x)$.

Find the sum of $p(x)$.


Then set the sum equal to 1 and solve the resulting equation.


## Note:

If the distribution is given in the form:
$p(x)=k x(14-x), x=1,3,5$
proceed as shown opposite to find $P(X>1)$.


Find the mean, variance and standard deviation of the discrete random variable with distribution:

$$
p(x)=\frac{x(14-x)}{91}, x=1,3,5
$$

Define $p(x)$.
Compute the mean using the mean formula.
Note that two ways are illustrated opposite.


Store the mean value by defining a variable to have the value attained.

Note that any letter may be used in place of $\mu(\mathrm{mu})$.

|  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | \% Edit Action Interactive |  |  |  | $\cdots$ |  |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
| $\frac{337}{91} \Rightarrow n$ |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | $\frac{337}{91}$ | ${ }^{37}$ |
|  |  |  |  |  |  |  |  |  |
|  |  | aßr |  |  | Math |  | Symbol |  |
| $\alpha$ |  | $r 8$ |  | 3 | $\square$ | $\theta$ |  |  |
| $\lambda$ | ${ }^{\circ}$ | v 5 | 5 | $\pi$ | P | $\sigma$ | ז |  |
| $\varphi$ | $x$ | $\Psi \omega$ |  |  |  |  |  | , |
| à | á | ${ }^{\text {à }}$ | ${ }^{\text {a }}$ | à | ¢ | 9 | e | $0^{\text {a curs }}$ |
| 5 |  | - |  |  | Spac |  |  | EXE |
|  |  | Stand | dard |  | Real | Rad | d | Im |

Compute the variance, using $\mu$ in your working.

Finding the square root of the variance value returns the standard deviation.

| \% Edit Action Interactive |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| $\stackrel{0.5}{4}$ |  |  |  |  |  |
| $\operatorname{sum}\left((\{1,3,5\}-\mu){ }^{2} \times \mathrm{p}(\{1,3,5\})\right.$ |  |  |  |  |  |
|  |  |  |  | $\frac{17016}{8281}$ |  |
| $\sqrt{\text { ans }}$ |  |  |  |  |  |
|  |  |  |  | $\frac{2 \cdot \sqrt{4254}}{91}$ |  |
| $\square$ |  |  |  |  |  |
| Alg | Standard | Real | Rad |  | 而 |

Find the mean, variance and standard deviation of the discrete random variable with distribution:

$$
p(x)=\left(\frac{1}{4}\right)^{x}, x=1,2,3, \ldots \ldots .
$$

Define $p(x)$.
Compute the mean using the appropriate formula.
Compute the variance using the appropriate formula.
Note:
The use of the symbols $\mu(\mathrm{mu})$ and $\sigma$ (sigma) are not necessary.


### 7.1.2 Finding probabilities, the expected value, the variance \& the standard deviation associated with the binomial distribution

Suppose a random variable $X$ has binomial distribution with $n=10$ and $p=0.4$. Find $\mathrm{P}(X=4)$.

Method 1:
Launch the statistrs application.

From the Calc menu, choose Distribution.

Then choose the Binomial PD option and tap Next.


Enter the values for x , Numtrial and prob.

Tap Next and the probability value for $\mathrm{P}(X=4)$ is returned.

Note:
A nice histogram of the distribution can be made by tapping the graph icon $\qquad$ in the top left corner.

The plot can be traced to compute any other individual probabilities for this distribution.


Method 2:
An expedient method.

Enter the $\sqrt{\alpha}$ man application.

From the Interactive menu and the Distribution/Inv. Dist sub-menu, choose Discrete, then binomialPDf command.

Enter the correct inputs, tap OK and the probability value for $\mathrm{P}(X=4)$ is returned.




Suppose a random variable $X$ has binomial distribution with $n=10$ and $p=0.4$.
Find the $\mathrm{P}(X>6)$.

Method 1 - this method requires us to determine 1- $\mathrm{P}(X<6)$.

Launch the

application.

From the Calc menu, choose Distribution.

Then choose the Binomial CD option and tap Next.


Enter the values for Lower, Upper, Numtrial and prob.

Tap Next and the probability value for $\mathrm{P}(X \leq 6)$ is returned.

Note:
A nice plot of the distribution can be made by tapping the graph icon $\psi$ in the top left corner.

The plot can be traced to compute any other cumulative probabilities for this distribution.


Now return to the Main application and compute 1 minus the probability value returned. prob can be found in the Catalog ue, or simply type it in.


Method 2:
An expedient method.

Enter the

application.
Enter $\qquad$

From the Interactive menu and the
Distribution/Inv.
Dist sub-menu, choose
Discrete, then
binomialCDf command.

Enter the correct inputs, tap OK

 and the probability value for $\mathrm{P}(X>6)$ is returned.


Suppose a random variable $X$ has binomial distribution with $n=10$ and $p=0.4$. Find the mean, variance and standard deviation of $X$.

Enter the $\sqrt{\alpha}$ Main application.

Enter the binomial formula.

Highlight the input and from the Interactive menu, choose Define and define Bin(r,n,p).


### 7.2 Continuous probability distributions

### 7.2.1 Finding $\boldsymbol{k}$, graphing and finding the mean and variance

A continuous random variable, $X$, has distribution described by $f(x)=k e^{-2 x}, x \geq 0$.
Find $k$, draw the distribution and then find the mean, variance and standard deviation.

Enter the $\sqrt{\alpha}$ Main
application.
Define the function $f(x)$.
We know that the total area under this curve is 1 (as it is a probability distribution). So we can find $k$ as seen opposite.

We could now solve for $k$, but in this case $k$ is clearly 2 .

A quick way to graph this function is to tap the application launcher icon and select $\Psi$. Then in Main Work Area, enter $\mathrm{f}(x) \mid k=2$ and press EXE.

Then 'drag and drop' the result into the Graph View window.

Then utilise the correct formulae for the mean and variance of a continuous random variable.

## Note

It is not necessary to use the Greek symbols (followed by the equal sign) in this computation.

$$
\text { - }+2
$$




### 7.2.2 Standard normal distribution

Find $\operatorname{Pr}(Z<2)$ using the cumulative normal distribution.
Method 1:
Enter the $\qquad$ application.

From the Calc menu, choose Distribution.

Then choose the Normal CD option and tap Next.

Enter the values for Lower and Upper. (Check the values for the standard deviation and mean.)

Tap Next and the probability value for $\operatorname{Pr}(Z<2)$ is returned
 (see below).

The next screen will also give the option to sketch the probability region.

Tap $\#$ to sketch the probability region.


Method 2:
An expedient method.

Enter the

application.
From the Interactive menu and the
Distribution/Inv.
Dist sub-menu, choose
Continuous, then normCDf command.

Enter the correct inputs, tap OK and the probability value for
 $\operatorname{Pr}(Z<2)$ is returned.

### 7.2.3 Inverse cumulative normal distribution

How do I calculate a boundary given a proportion/probability associated with a normal distribution?

Suppose the girls aged between 10 and 12 years old in a given country have heights that can be modeled approximately normally with mean 130 cm and standard deviation 2.7 cm .
If $35 \%$ of the girls fail to meet the height requirement for an amusement park ride, find the minimum acceptable height of the ride.

## Enter the <br>  application.

From the Calc menu, choose Inv. Distribution.

Then choose the Inverse Normal CD option and tap Next.

Enter the values for the tail setting, probability, standard deviation and mean.

Tap Next.


The next screen will give the boundary value and the option to sketch the probability region.

Tap $\forall$ to sketch the probability region.


How do I calculate unknown population parameters for a normal distribution?
The weights of a certain variety of squash are normally distributed. If $5 \%$ weigh more than 30 g and $10 \%$ weigh less than 15 g , find the mean and standard deviation of the distribution of squash weights.

Launch the statistits
application.
From the Calc menu, choose Inv. Distribution.

Then choose the Inverse Normal CD option and tap Next.

Enter the values for the tail setting and prob. (Check the values for the standard deviation and mean.)


Tap Next and the Z-score will be returned.


Repeat this process to calcualte the Z-score associated with the second statement about the population.


Launch the $\sqrt[m a n]{\alpha}$ application.
Use the Math1 keyboard for the simulaneous equations template

## 偪.

Use the Z-score formula to enter two equations in terms of $\mu$ and $\sigma$ (obtained from the abc keyboard, under the symbol tab).

Use ${ }^{\left[0.5 \frac{1}{2} 12\right.}$, if required to see the answer in decimal form.


Find the value of $c$ if $\operatorname{Pr}(-c<Z<c)=0.9370$.

Method 1:
Enter the statistis application.
From the Calc menu, choose Inv. Distribution.

Then choose the Inverse Normal CD option and tap Next.

Enter the values for the tail setting and prob. (Check the values for the standard deviation and mean.)


Tap Next and the unknown Z scores will be returned.

The next screen will give the unknown $z$ values and the option to sketch the probability region (this is always a very good idea).

Tap to sketch the probability region.


Method 2:
An expedient method.
Enter the

application.
From the Interactive menu and the
Distribution/Inv.
Dist sub-menu, choose
Inverse, then invNormCDf command.

Enter the correct inputs, tap OK.



## 7．2．4 Equating probabilities

A continuous random variable，$X$ ，has distribution described by $f(x)=0.05 e^{-0.05 x}, x \geq 0$ ． A second continuous random variable，$Y$ ，is distributed normally with mean 22 and standard deviation 2．Find k，such that $P(X>k)=P(Y<k)$ ．

This problem requires us to solve the following equation：

$$
\int_{k}^{\infty} f(x) d x=\int_{-\infty}^{k} g(y) d y \text { where } g(y) \text { is the 'normal distribution' function. }
$$

We can do this as follows：
 define the functions as shown． Note the change of variables．
normCDf can be found in the catalogue．

Choose a sensible view window， $\operatorname{tap}$ 堅武。


Graph and then from the Analysis menu and the G－ Solve sub－menu choose Intersection．

So $k=21.2$ ．


## 8. Financial Calculations - TVM

Launch the Financial application; you will see it has an amazing array of options.


Tap Compound Interest.
You will see that the variables associated with compound interest (including Annuity calculations) are laid out with input boxes ready to be filled.

If you are not sure what a variable means, tap into that working line and then tap Help at the bottom of the screen.


Suppose that we wish to determine the size of the repayments on a loan of $\$ 400000$ for which the interest rate is $6 \%$ p.a. compounded monthly and the term of the loan is for 30 years.

Enter the variables, as seen opposite, and then simply tap the variable we wish to compute; in this instance tap PMT.


Now tap the Calc(l) menu and note the Amortization option.

The appropriate values from our previous problem are carried over and now we can carry out some 'what if' exercises.

We can do this for any period within the life of the annuity.


PMI is the number of the first installment in the period being considered and PM2 is the number of the last installment in that period.

Tap BAL to have the balance calculated.

We can see that after the first 10 installments are paid, the annuity has a balance of $\$ 395927.18$.


## 9. Complex Numbers

### 9.1 Complex calculations

Launch the $\sqrt{\alpha}$ main application.
To work with complex number calculations, the ClassPad needs to operate in Complex mode.

To change the mode the calculator is operating in, you can simply tap on the specific mode name in the status barto change it.

Alternatively, tap (on the menu bat) then Basic Format.


The Complex Submenu contains commands that can be used in complex number calculations.

Explanation of the commands:
arg - will output the argument of a complex number. cong - will output the conjugate complex number. re - will output the real part of a complex number. im - will output the imaginary part of a complex number. cExpand - expands a complex expression to rectangular form.
compToPol - converts a complex number into its polar form.
compToTrig - converts a complex number into its trigonometric form.
compToRect - converts a complex number into its
 rectangular form..

For $z=1+\sqrt{3} i$, find the following:
a) argument of $z$ over $[0,2 \pi]$.
b) conjugate of $z$.
c) real part of $z$.
d) imaginary part of $z$.

Enter the equation by soft keyboard input for $\boldsymbol{i}$.

Tap Interactive, then Complex, followed by arg.

Continue using the Complex
Submenu to complete the complex calculations.


## Note

Conversions from Cartesian form to polar form can be made using the compToTrig and compToPol commands． And vice versa using the $c$ Expand command．


## 9．2 Regions in the complex plane

Sketch the subset of the complex plane of $S:\{z:|z-1|=5\}$ ．

Firstly，tap（on the menu bar）then Basic Format． Make sure you tick the
Variable is Real check box．Then tap Set．

Assign $x+i y=z$ ．
Enter the equation by soft keyboard input Math 3 using

$$
\square \text { and } i
$$



| \％Edit Action Interactive |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| ${ }^{0.5} 5$ |  | Simp | $\xrightarrow{\text { dad }}$ | v $\psi$ | V |
| $x+i y \rightarrow z$ |  |  |  |  |  |
| $\|z-1\|=5$ |  |  |  |  |  |
|  |  |  | ${ }^{2}+{ }^{2}$ | $2 \cdot \mathrm{x}+1$ |  |
| $\mathrm{ans}^{2}$ |  |  |  |  |  |
|  |  |  | $y^{2}-2$ | $x+1=$ | 25 |
| $\square$ |  |  |  |  |  |
| Math1 | Line | 틈 | $\sqrt{\square}$ |  | $\Rightarrow$ |
| Math2 |  | $e^{\prime \prime}$ | In | $i$ | $\infty$ |
| Math3 |  | $\frac{\mathrm{d}}{\mathrm{d}} \mathrm{\square}$ | $\frac{\mathrm{d}}{\mathrm{da}} \mathrm{\square}$ | 辰 | $\lim _{\square \rightarrow \square}$ |
| Var | $111$ | ［ | ［㧽］ | 号口 | 品口 |
| abc | $\sin$ | cos | $\tan$ | $\theta$ | $t$ |
| V | － | 餭 | 寝 | ans | EXE |
| Alg | Standa |  | Cplx | Rad | 四 |

Tap $\#$ to open the graph view window．

Highlight the answer，then drag and drop into the graph window．

Therefore， S is the circle with centre $(1,0)$ and radius length 5 units．


## 10. Vectors

### 10.1 Viewing vectors


To configure the settings, tap and then Geometry Format.

Tap Set once configured.


Tap Draw, Basic Object and select Vector.

Then tap on the Cartesian Plane in two different spots, the first for the tail of the vector and the second for the head.

A vector appears, labeled as $r$ in this case.


Now tap on the selection tool, and then on the vector itself.

Next, tap the "take me around the corner" icon, to reveal the measurement bar.


You can now edit the components and change the vector.



Now tap on the Cartesian Plane in 'free space' to deselect the vector and tap on the point representing the vectors tail.

You can then edit its co-ordinate, for example to $(0,0)$.

Using the Zoom to Fit option from the View menu completes the task.




## 10．2 Operating with vectors

Enter the $\sqrt{\alpha}$ Main
application．
You can use［回］and［日］keys on the Math2 soft keyboard to enter vector quantities

Enter a vector by tapping［这， the column matrix template．

Tapping it twice will allow you to enter a vector with three dimensions．


In the Interactive menu，you will see a Vector submenu and all of the commands it contains．


Most of these uses are self－ explanatory；the following screen shots illustrate some of the functionality．

Enter the vector（s）first，highlight and then choose
Interactive，Vector and the command you require．

| \％Edit Action Interactive |  |  |
| :---: | :---: | :---: |
|  |  |  |
| unitV（ $\left[\begin{array}{l}7 \\ 1\end{array}\right]$ ） |  |  |
| $\left[\begin{array}{l}\frac{7 \cdot \sqrt{2}}{10} \\ \frac{\sqrt{2}}{10}\end{array}\right]$ |  |  |
| $\operatorname{norm}\left(\left[\begin{array}{l}7 \\ 1\end{array}\right]\right)$ |  |  |
| toPol $\left(\left[\begin{array}{l}7 \\ 1\end{array}\right]\right) \quad 5 \cdot \sqrt{2}$ |  |  |
|  | $\left.\begin{array}{l}5 \cdot \sqrt{2} \\ \angle\left(\tan ^{-1}\left(\frac{1}{7}\right)\right)\end{array}\right]$ |  |
| D |  |  |
|  |  |  |
| Alg Standard | Cplx Rad | 而 |



### 10.3 Vectors that are functions of time

Suppose $r=i \cos t+2 j \sin t$ where $t$ is time. What path does this describe?

This path can be plotted by considering this as a function in parametric form, namely:

$$
\begin{aligned}
& x=\cos t \\
& y=2 \sin t
\end{aligned}
$$



From the Type menu, tap
ParamType.
Enter the $x$ and $y$ components.
Tap the graph icon, $\qquad$
The path appears to be elliptical.


Note that the settings for the values for $t$ can be found in the View Window settings (scroll to the bottom) window.

Tap [昆7, to access when the graph view window is active.



## 11．Graphing relations，circles and ellipses

This section explains how to graph circles and ellipses when the ClassPad is operating in the国 Conics application．（You can also use this application to graph parabolas，hyperbolas and other general conics．）


The following describes the purpose of each button that is located on the tool bar while the Conics Editor window is active．

| Draw a graph | H |
| :---: | :---: |
| Insert a Conics Form on the Conics Editor window | ［ $\times(\underline{y}$ |
| Adjust the equation on the Conics Editor window so it fits a Conics Form |  |
| Display the View Window dialogue box to configure Graph window settings | 平枵 |

The following describes the buttons located on the tool bar while the Conics Graph window is active．

| Re－draw a graph | 0 |
| :---: | :---: |
| Makes the Conics Editor window active | f（x） |
| Display the View Window dialogue box to configure Graph window settings | 速 |
| Activate the pan function for dragging the Graph window |  |
| Enlarge the part of the screen bounded by a box | ？ |
| Configure View Window y－axis parameters and redraw the graph so it fills the Graph window along the $y$－axis | 困 |
| Display the coordinates at a particular point on a graph | $x^{\text {x }}$ |

Sketch the graph of the circle with centre $(2,2)$ and radius 1.

Enter the equation by using the soft keyboard input or by using the preset conics form menu $\operatorname{tap} \underset{y}{f\left(f_{y}\right)}$.

If using the preset menu, select the form you wish to graph. Tap OK.


If using the preset method, the selected form will be displayed in the Conics Editor window. The equation can now be completed by giving $\mathrm{H}, \mathrm{K}$ and R numerical values.

Once modified, tap to graph.


## Note

Various graph Analysis tools can be used when the Conics Graph window is active.


Sketch the graph of the ellipse with equation
$\frac{(x-1)^{2}}{4^{2}}+\frac{(y-2)^{2}}{9^{2}}=1$.

Enter the equation by using the soft keyboard input or by using the preset conics form menu $\operatorname{tap}$ f(y).

If using the preset menu, select the form you wish to graph. Tap OK.


If using the preset method, the selected form will be displayed in the Conics Editor window. The equation can now be modified.

Tap $\square$ to graph.

Use the Zoom menu or change the View Window settings, 地, to be able to view the conic in its entirety.


Note: Various graph analysis tools can be used when the Conics Graph window is active.


## 12. Using the Geometry application

How do I build it? How do I measure it? How do I animate it?

### 12.1 Introduction

The ClassPad is the only hand-held device to be equipped with the unique constraint-based

욱 Geometryapplication. While you are able to make constructions in a manner similar to that employed by GSP or Cabri Geometre, setting constraints when forming objects is often far more expedient and saves a lot of construction getting in the way of the key learning point at hand.

This section focuses on building by setting constraints.

### 12.2 Drawing

Launch the
 application.

The Draw menu contains many tools for both drawing and construction.

Icon shortcuts exist for many of these options.


Select the Line Segment option by tapping $\rightarrow$.

The tool is selected when it is highlighted blue.

A line segment is defined by two points, so tap in two different places on the screen.

Note that the line segment tool is still selected. Tap the selection tool in icon to activate the selection tool.


So, we now have drawn three objects, a line segment and two points. Each object has a set of properties that the ClassPad can measure.

### 12.3 Measuring the properties of objects

Tap the arrow pointing to the right at the end of the icon bar,

This takes you around the corner to the measurement bar - it will be mostly empty to begin with.


Tap on the line segment (not one of the end-points, but in the centre of the line segment).

Note that the first option is for the ClassPad to measure the length of the line segment.

If you tap the small left-most drop down arrow you will see what else the ClassPad can measure.

In order we have: length, slope, angle (from the positive $x$-axis), equation and the last option
 offers the chance to name the line.

Tap in free-space and you will see that nothing is selected and so no measurements are shown.

Now tap on a point and see what is measured.


### 12.4 Moving objects around

Go around the cormer, $\square$ and make sure the selection tool is highlighted.

Tap in free-space.
Now tap on the line segment and then put the stylus back on the line, but this time leave the tip on the glass and then drag the stylus across the glass, the line segment should move.


Tap in free space and then tap on a point.
Then go back and put the stylus on the point, and drag across the glass. Note that the point stays highlighted and so you should be able to go back on it and move it again.

Tapping in free-space de-selects any object and allows you to reselect from scratch.


### 12.5 Setting a constraint

Suppose we want to make 'fred' 5 units long and have a gradient of zero and make these properties fixed.

Tap in free space and then go around the corner, $\square$. Highlight the line segment and measure its length.

Change the length to 5 and tap the (or press EXE).

Note the $\mathbf{B}$, indicating the constraint has been set and the
 length is fixed to be five units.

Now measure the line segments slope.

Note the $\boldsymbol{m}$, indicating the slope is changeable (not constrained).

Now change the value to 0 and tap the (or press EXE).

The $m$ will change to $B$, indicating the constraint has been set and the slope is fixed to be zero units.


### 12.6 Drawing other objects

Draw two other line segments to form a triangle.

Then draw a circle within the bounds of the triangle.


Now, to make this triangle an incircle we can use the 'tangency' property.
Tap to reveal the measurement bar.
Select the circle and one side ofthe triangle.
Note that the tangency property says No. To make it say Yes and constrain it to be so, tap the and it will change to $\mathbf{B}$.
Tap in free space, select the circle and one other side of the triangle and repeat.


Repeat again for the third side and an incircle is created.

Move the vertices and note the system is constrained so the sides of the triangle are always tangential to the circle.

### 12.7 How do I animate?

Suppose I want to have point C move along a line segment.

First draw the line segment.
Then constrain C to the line segment using interest tool (select both objects and tap $\qquad$
Then click in free-space.
Any point can be made to move along any curve provided the curve has a start and end. Hence, an infinite line is of no use to us
 when making an animation.

Select point C and the segment IJ.

Then go to the Edit menu and the Animate sub-menu and choose to Add Animation.

Then return to the same menu and choose one of the Go options and the animation should start.


### 12.8 How do I display measurements?

Three ways exist to display measurements.

Once you have drawn an object you can select it and then display the measurement bar (tap $\square$ ).

Note that the ClassPad can measure different properties of an object.

For a line segment, it can measure length, gradient, angle from the positive $x$ axis, equation and finally you can attach text to the object.


You can take any measurement and drag it onto the working area.

This allows you to watch the measurements change as you move or animate the structure.

You can edit the default word 'length' to make it what you like.


You can also attach a measure to an angle.

Construct a second segment CD.
Select both segments and use the Attached Angle command.

The angles measure will change as you change the construction by dragging or while animating.


### 12.9 How do I do a calculation?

You can perform a calculation using the measurements you have displayed.

Be sure the measurement bar is visible (as opposed to all the drawing tools) and then use the Expression command from the Draw menu.

This will result in the cursor flashing in the measurement bar waiting for input.


To add the two angles together, tap on the number that precedes the measure ( 1 and 2 ) in this case, putting a plus in between.

Pressing EXE results in the calculation being performed.

You can edit the text EXPR = to be whatever you like.

The calculation will change in response to the construction being changed by dragging or animation.



## 13．Algy 2：Checker of students＇working

Unlike most other mathematics software，Algy 2 does not compute and display answers to calculations．Algy 2 checks the logic of the user＇s：
－numeric computation，
－symbolic computation or
－algebraic manipulation．

Algy 2 is a checker of thinking，particularly symbolic manipulation and exact numerical computation．The user can input the results of their thinking and Algy 2 will check the thinking and then report whether the thinking is correct or incorrect．

The user is able to input single or multiple lines of related working and Algy 2 will check each line against the top line or each line against the previous line．The latter allowing the user to identify which line of working contains an error．

By providing a way to check their logic，Algy 2 encourages thinking，perseverance and experimentation with numerical computation，symbolic computation and symbolic manipulation．

| ＊File Edit－Check Help＊ |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| ＊${ }^{\text {＋}}$ | ＋7 | and | or | NoS ${ }_{x}$ |  |
| $\begin{array}{cl}  & 3 \cdot x+2=-5 \cdot x+5 \\ x & -2 \cdot x+2=5 \\ \Rightarrow & -2 \cdot x=3 \\ \Rightarrow & x=-\frac{3}{2} \\ & \square \end{array}$ |  |  |  |  |  |
| Math1 | Line | 旦 | $\sqrt{\square}$ | $\pi$ | $\Rightarrow$ |
| Math2 | $\square^{\square \prime}$ | $e^{\square}$ | ln | $\log _{\square} \square$ | $\sqrt{\square}$ |
| Math3 | － | $\mathrm{x}^{2}$ | $\mathrm{x}^{-1}$ | $\log _{10}(1)$ | solve（ |
| Trig |  | toDMS | \｛昌 | \｛ \} | （） |
| Var |  |  |  | 。 | r |
| abc | $\sin$ | cos | tan |  |  |
| $\checkmark$ | $\checkmark$ | 㖪 |  | ans | EXE |
| vPrev | Stand |  | Real | Rad | 而 |

## Where do I get it？

ALGY 2 will run on the Casio ClassPad and Windows equipped PCs．It can be downloaded from www．stepsinlogic．com

It is free with every purchase of a ClassPad in Australia．Look for your voucher inside your ClassPad box．

If you like ALGY 2 please tell us．If you do not，please tell us．Share your thoughts on the topic by sending an email to support＠stepsinlogic．com

## 14. Managing your ClassPad II

### 14.1 Touch Panel Alignment

To ensure perfectly accurate tapping, the touch panel can be aligned easily.

Tap MENU and then choose Touch Pad Alignment.

Then use the stylus to tap in the centre of each of the four crosses.


### 14.2 Operating System (OS)

The ClassPad hand-held device consists of two elements, the hardware and the software. Regular software updates will be supplied by CASIO as improvements to the software occur.

To determine the OS installed on your ClassPad, tap MENU and then choose Version.

At the time of writing, the current OS was
Version 01.00.0000.0000


### 14.3 Updating ClassPad to latest OS

Visit http:/ /edu.casio.com to determine the latest OS and if necessary download the latest OS.
The updating process is simple, run the update software on your computer, plug your ClassPad into the computer via the USB port and follow the instructions on the update software.

However, please ensure that if you are using a laptop computer it is plugged into the mains power supply. If the laptop loses power during the update process, the ClassPad may be rendered unusable.

### 14.4 Types of memory

The ClassPad has two different storage memory 'compartments' inside the case:

1. ClassPad internal memory ( 5.5 MB ), which holds all the data you generate on the ClassPad (calculations, files, ....).
2. USB flash memory ( 24 MB ), which can be thought of as a 'USB flash drive' and can store many things including regular computer files.

### 14.5 Connecting a ClassPad to a computer (via USB)

The Classpad has a mini-USB port on its top edge. A USB to mini-USB cable is supplied with each ClassaPad. When you plug it into a computer (Mac or Windows) the screen seen opposite will appear. A description of each option follows.

## 1. USB Flash

Tapping option 1 will result in the Flash memory part of your ClassPad mounting on your computer. You can then add files to it as required. More details are provided later in this chapter.

## 2. Screen Receiver

Computer software called Screen Receiver can be freely downloaded at http:// edu.casio.com
Once installed on your computer and launched, you can display the screen of ClassPad on your computer screen and then project that via a computer projector onto a big screen.


Screen capture can also be performed using this software. The screen shot files can be saved as a picture file and/or pasted into worksheets and other documents. Automatic prompts along the way will help you with this process.

## 3. Screen Receiver (XP)

Use this option to connect to the Screen Receiver software if you are using Windows XP.

## 4. Projector

The ClassPad can be directly displayed by some models in the CASIO data projector range.

### 14.6 Backing up and restoring the ClassPad

The data you create on the ClassPad may be important. So it is not lost if the ClassPad malfunctions, it is wise to regularly backup your ClassPad.

Tap MENU and then choose Save As.

This allows you to make a file containing all the data inside your ClassPad's internal memory.

The file extension is .vcp


Rename the file to something like:
backup04072013.vcp and tap Save.

This file is now saved to the flash drive section of the ClassPad. For safe keeping, you should transfer it to a computer.

Connect the ClassPad to a computer via the USB port, select the USB Flash option.


The drive will mount on your computer like a normal memory stick and you can drag the file to a folder on your computer.

Safely disconnect the ClassPad from the computer.


To restore the contents of a ClassPad to the contents of a backup file, make sure the backup file is in the flash memory (in this case a later backup) and then tap MENU and then choose Open.

Select the file you want to restore from and tap Open.

Choose the appropriate option with respect to erasing and over writing.

Tap OK.


### 14.7 Add-in applications

Algy 2 is an example of an Add-in application. It is not installed at the factory, but can be installed later. The fx-CP 400 is able to accept .c2a Add-in files.

Algy2_0_1_CP400.c2a can be retrieved from
http://www.stepsinlogic.com
To install, connect the ClassPad to a computer, choose USB Flash mode and then drag the .c2a file into the root directory of the flash memory.


Safely disconnect the ClassPad from the computer and you will be able to locate the application on the ClassPad's Menu and launch it for use.


### 14.8 Displaying pictures

Pictures can be displayed on the ClassPad.
The ClassPad accepts a special picture file format, namely .c2p
File types like .jpg can be converted to .c2p.

Once the image you want to display is converted, connect the ClassPad to a computer, choose USB Flash mode and then drag the .c2p file(s) into the folder named Picture on the flash memory.

Safely disconnect the ClassPad from the computer.


To view and work with a picture,
 and make the graph window active by tapping in it.

Tap $<$ and then tap Open Picture.

Select the picture you want to view.

Proceed as desired.



### 14.9 File and data transfer

The files and data created on the ClassPad can be transferred to another ClassPad, allowing people to share files.

## You can either:

1. Transfer the complete contents of one ClassPad to another ClassPad.
2. Transferring a variable (ClassPad language for a single file or other saved data) from one ClassPad to another Classpad.

### 14.9.1 Complete contents transfer

The complete contents of the ClassPad can be saved as a .vcp file. This process is identical to the backup process outlined in Section 14.6.

The advantage of this process is that you can email the .vcp file to the person with whom you want to share the contents.

### 14.9.2 Individual variable transfer via USB



The next window shows you the directories in the Flash memory of the ClassPad.

Tap OK to save the spreadsheet in the form of a .xcp file with the same name as the spreadsheet, in this case cereal-(Mem). xcp, in the root directory of the Flash memory area.

You can now connect your ClassPad to a computer, choose USB Flash, locate the .xcp file and email it to another person.


To import the contents of a .xcp file into a different ClassPad, first connect the ClassPad to a computer and choose USB Flash. Copy the .xcp file into the root directory of the flash memory folder.

Safely disconnect the ClassPad.

Launch the $\sqrt[\pi]{d \pi}$ system applicatio
and check View Storage and
Import.
Tap Select.
Locate the .xcp file, in this case named cereal-(MEM).xcp.

Check it and then tap Import.
Choose where you would like to save the file.

The spreadsheet will now be accessible in the Classpad's memory for use.

### 14.9.3 Individual variable transfer via 3pin

A second transfer port can be found on the top edge of the ClassPad. It is called the 3 pin port.
Individual variables can be transferred from one ClassPad to another using the 3pin cable that is supplied with each ClassPad.

The
 application is used to transfer variables using this method.

From the Setup menu choose 3 pin as the Cable Type on both ClassPads.
Connect the ClassPads using the 3 pin cable. Ensure it 'clicks' when you insert it in the port.
From the Link menu, set one ClassPad to Receive and the other ClassPad to Transmit.

On the unit transmitting, select the items for transmission (multiple items can be selected). Tap OK and the transmission will take place.

## 15. Solving equations

Equations may have none, one or more than one solutions. The solutions can be represented graphically and can be expressed in 'exact form', meaning the number is expressed as a fraction, a surd, in terms of pi or $e$ or as a decimal approximation.

When a computer solves an equation it can use one of two methods:

1. Numerical iteration
2. CAS (Computer Algebra System) algorithm

Numerical iteration will result in solutions represented as decimal approximations and not all solutions may be found.

A CAS algorithm will return all solutions in exact form - most of the time! Sometimes however, it may fail or give remarkably complicated results and take a long time to do it. Remember you can always use your mind!

When solving equations using the ClassPad, it is suggested you first figure out if you require solutions to be given in exact form. If you do, use CAS; if you do not, then use numerical iteration.

### 15.1 Solving equations using numerical iteration

Solve the equation $5 x^{2} e^{-x}=2$ with solutions given as decimal approximations.
Launch $\sqrt{\alpha}$ Main

Set the modes to Alg, Standard,
Real and Rad.

Enter the equation and select it.
Choose solve from the Interactive menu.
Check Solve numerically. Choosing Solve numerically results in the machine using numerical iteration.

Tap OK.
Note the warning! Tap OK.


Three solutions are given.
It is wise to make a graphical representation of the solutions to get a sense of if anymore exist.


Tap $\forall$ and drag and drop each side of the equation into the graph window.

From the Analysis menu, the Intersection command can be chosen.

Three solutions can be seen, you should be able to reason why there are no more.


### 15.2 Solving equations using CAS

Solve the equation $4 \cos ^{2}(2 x-\pi)=1$ for $-\pi<x<\pi$ giving answer in exact form.

Enter the equation and select it.
Choose solve from the
Interactive menu.
Select Solve.
Choosing Solve results in the machine using a CAS algorithm.


Tap OK.
Eight solutions are given, in exact form.

It is still wise to make a graphical representation of the solutions.


### 15.3 When CAS cannot solve an equation

Try to solve the equation $5 x^{2} e^{-x}=2$ using CAS.

In this case, even though we 'request' CAS to be used, the ClassPad realized it could not use CAS and switched to using numerical iteration.

There is no analytical method programmed into the ClassPad to solve this equation. Can you solve it analytically?

As a result the 'more solution' warning appears and decimal approximations are returned.


### 15.4 When CAS takes some time

Try to solve the equation $3 x^{3}-6 x^{2}-6 x-1=0$ using CAS.

Well it turns out that the CAS can solve this equation using an analytical method. But, it takes some time, and the solution is 'interesting'.

Watch the bottom right of screen for the 'spinning wheel', it indicates the ClassPad is thinking hard!

If it spins for too long, tap Esc on the toolbar at the bottom of the screen.


It is not likely you will need this sort of solution, so solve such an equation using numerical iteration.


### 15.4 The moral of the story with equations

It is possible you may enter an equation, try to solve it using CAS and an error message will be retuned, e.g. Insufficient Memory. This is not a common occurrence, but if it does happen, it is very unlikely you require solutions in exact form - so do not try to solve the equation using CAS.

Each method of solving equations using a ClassPad has pros and cons.
Using numerical iteration via a graph requires you to set an appropriate view window as only solutions that are visible will be found.

Using numerical iteration via 'Solve numerically' may not give you all the solutions to the equation, and will give the solutions as decimal approximations.

Using CAS via 'Solve' may sometimes give you interesting solutions.
The moral is simple. Figure out whether or not you need solutions in exact form, if you do, use CAS or your mind, if you do not, use numerical iteration.

## Appendix 1 - Statistics with the Statistics application

In this section we use the

## A1.1 Univariate data

## A1.1.1 Working with ungrouped univariate data

The height of twenty Year 11 students from across Australia was recorded. The results, in centimeters, are given below.

$$
\begin{aligned}
& \begin{array}{l}
185,176,184,175,173,183,182,184,174,174, \\
169,179,190,175,178,203,145,188,177,162 .
\end{array}
\end{aligned}
$$

Calculate the five number summary ( $\mathrm{min}, \mathrm{Q} 1$, median, Q3, max.) for the sample and make a histogram.

Enter data into listll (or an empty list).

Select Calc, then One-Variable.


| \% Edit Calc SetGraph * |  |  |
| :---: | :---: | :---: |
|  | One-Variable |  |
| $\mathrm{lis}^{\text {Two-Variable }}$ |  |  |
|  | is Regression | 3 |
| 5 T | Test |  |
| 6 In | Interval |  |
| $8{ }^{7}$ D | Distribution |  |
| ${ }_{9}^{8}$ In | Inv. Distribution |  |
| 10 D | DispStat |  |
| 11 | 103 |  |
| 12 | 179 |  |
| 13 | 190 |  |
| 14 | 175 |  |
| 15 | 178 |  |
| 16 | 203 |  |
| 17 | 145 |  |
| 18 | 188 |  |
| 19 | 177 |  |
| 20 | 162 |  |
| 21 |  |  |
| Cal- |  | $\nabla$ |
| ${ }^{1}$ |  | $\checkmark$ |
| [ 21]= |  |  |
| Rad Auto | Auto Standard | 皿 |

Select the listl as the XList using the drop down menu. Tap OK.

The Stat Calculation screen will appear containing a basic statistical summary of the selected listed data.


To draw a histogram of the data tap SetGraph then choose Setting ....

Set up Statgraph 1.
Set Draw to On.
Type to Histogram.
Xlist to list1
Freq to 1.
Tap Set.

Tap to draw the histogram.


## A1.1.2 Working with grouped univariate data

The following table shows the number of "Smarties" in each of 50 packets.

| \# of Smarties | Frequency |
| :---: | :---: |
| 40 | 1 |
| 41 | 8 |
| 42 | 29 |
| 43 | 7 |
| 44 | 4 |
| 45 | 1 |

a. Calculate the mean, median and mode.
b. Find the total number of Smarties in 50 packets.

Enter data into listland frequency into list (or other empty lists).

Select Calc, then
One-
Variable.


Select listl for the XList and list for the Frequsing the drop down menu. Tap OK.

The Stat Calculation
screen will appear containing a basic statistical summary of the selected listed data.

Note: You can rename the lists; bowever, do so before entering your data. Once named, the list is considered
 to be a variable.

## A1.1.3 Histogram

The frequency table shows the length ( $)$ of 80 fish caught in a fishing competition.

| Length $(\mathrm{mm})$ | Frequency |
| :---: | :---: |
| $295 \leq l<305$ | 8 |
| $305 \leq l<315$ | 17 |
| $315 \leq l<325$ | 19 |
| $325 \leq l<335$ | 13 |
| $335 \leq l<345$ | 10 |
| $345 \leq l<355$ | 6 |
| $355 \leq l<365$ | 4 |
| $365 \leq l<375$ | 3 |

Draw a histogram.

Enter the midpoints of each class into listl, frequency into liste.

Tap (ullo: on the tool bar. (Or, select SetGraph from the menu bar, then Setting.)

Adjust the Set StatGraphs options. Press Set.


Tap on the tool bar to make the graph.

The Set Interval box will appear - set HStart to 300 and HStep to 10 (this is critical). Press OK.

The histogram will appear in the StatGraph window. (Press Analysis, then Trace, to display the XList and Freq on the histogram.)



## A1.1.4 Box plot

The height of twenty Year 11 students from across Australia has been recorded. The results, in centimeters, are given below.

$$
\begin{aligned}
& \begin{array}{l}
185,176,184,175,173,183,182,184,174,174, \\
169,179,190,175,178,203,145,188,177,162 .
\end{array}
\end{aligned}
$$

1) Construct a box plot with this data.
2) Hence, state the five figure summary (min, Q1, median, Q3, max) for the sample.

Enter data into listl (or an empty list).

Tap $\boldsymbol{H l}_{\circ}^{\circ}$ - on the tool bat. ( $\mathbf{O r}$, select SetGraph from the menu bar, then Setting.)

Adjust the Set StatGraphs options. Type: MedBox.
Make sure you do not tick the Show Outliers box.
Tap Set.


| Set StatGraphs |
| :--- | :--- |



Tap $\operatorname{lin}^{11}$ on the tool barto sketch the boxplot.

The box plot will appear in the StatGraph window.

Tap Analysis, then Trace. Use the cursor key or graph controller arrows (left/right) to jump between values.


Box plot with outliers
(Modified box plot) - utilises the $1.5 \times I Q R$ rule, which defines limits for "outliers".

Set up StatGraph 2 as a modified boxplot.
To make a modified box plot, tick the Show Outliers box.


## A1.2 Cumulative frequency curves (or ogives)

The frequency table shows the length () of 80 fish caught in a fishing competition.

| Length $(\mathrm{mm})$ | Frequency |
| :---: | :---: |
| $295 \leq l<305$ | 8 |
| $305 \leq l<315$ | 17 |
| $315 \leq l<325$ | 19 |
| $325 \leq l<335$ | 13 |
| $335 \leq l<345$ | 10 |
| $345 \leq l<355$ | 6 |
| $355 \leq l<365$ | 4 |
| $365 \leq l<375$ | 3 |

a. Add a cumulative frequency column to the table.
b. Represent the data using cumulative frequency curve.

Enter the midpoints of each class into listl, frequency into liste.

Use the formula cuml(list2) to calculate the cumulative frequency values in list 3 . Type this formula into the Cal cell at the bottom of list3.

Tap $\operatorname{Hil}^{\circ}$ : on the tool bar. (Or, select SetGraph from the menu bar, then Setting.)

Adjust the Set StatGraphs options. Press Set.


Tap $\operatorname{lin}_{11}$ on the tool barto sketch the curve.


## A1.4 Bivariate data

This section will use the following example to demonstrate bivariate data analysis with the ClassPad.
Swimming Pool Attendance and Daily Maximum Temperature
The operators of a local swimming pool record the following data:

| Day | Max. temp <br> ${ }^{\circ} \mathrm{C}$ | Attendance |
| :--- | :--- | :--- |
| 1 | 18 | 870 |
| 2 | 17 | 819 |
| 3 | 30 | 2168 |
| 4 | 16 | 714 |
| 5 | 20 | 1435 |
| 6 | 22 | 1458 |
| 7 | 16 | 819 |
| 8 | 12 | 406 |
| 9 | 14 | 231 |
| 10 | 15 | 572 |
| 11 | 16 | 603 |
| 12 | 17 | 839 |
| 13 | 15 | 572 |
| 14 | 15 | 806 |
| 15 | 18 | 1218 |
| 16 | 19 | 1007 |
| 17 | 23 | 931 |
| 18 | 21 | 1215 |
| 19 | 19 | 995 |
| 20 | 21 | 275 |
| 21 | 25 | 1894 |
| 22 | 29 | 2301 |
| 23 | 26 | 2207 |
| 24 | 24 | 2109 |
| 25 | 30 | 2564 |
|  |  |  |

a) Calculate the summary statistics for the two variables.
b) Construct a scatter plot to examine the relationship between attendance and temperature.
c) Calculate Pearson's product-moment correlation coefficient, $r$.
d) Calculate the coefficient of determination, $r^{2}$.
e) Calculate the equation of the least squares line.
f) Sketch the least squares line.
g) Make a table of residuals and a residual plot.
h) Use your equation to predict the attendance on a day of maximum temperature at $23^{\circ} \mathrm{C}$ and compare your result to Day 17.

Task:
a) Calculate the summary statistics for the two variables.

Enter temperature into listl and attendance into $l$ ist 2 . Remember to rename the lists first!

Select Calc then TwoVariable.



Select main $\backslash t e m p$ for the XList and main \attend for the YList using the drop down menu. Tap OK.

The Stat Calculation screen will appear containing summary statistics of the selected two variable data. Scroll down to see the $y$ variable statistics

## A1.4.1 Scatter plot

b) Construct a scatter plot to examine the relationship between temperature and attendance.

Tap He $_{\circ}^{\circ-}$ on the tool bar. (Or, select SetGraph from the menu bar, then Setting.)

Adjust the Set StatGraphs options. Press Set.

Tap on the tool bar to sketch the curve.



## A1.4.2 Correlation coefficient, $r$ and coefficient of determination, $r^{2}$

c) Calculate Pearson's product-moment correlation coefficient, $r$.
d) Calculate the coefficient of determination, $r^{2}$.

These tasks can be performed simultaneously, while also calculating the residuals.
With the List Editor window active, select Calc from the menu bar, Regression, followed by Linear Reg.

Adjust the Set
Calculation options. (Be sure to
a) change the Copy Formula setting to $y l$ and
b) Copy Residual setting to list3.)
Tap OK.


The Stat Calculation
screen will appear containing, correlation coefficient, $r$, and the coefficient of determination, $r^{2}$. (MSe is the mean square error.

Note: Once the Set
Calculation window is closed by tapping $0 K$, the least squares line will automatically be sketched in a Statgraph window.

Also, the residuals will appear in list 3 in the List Editor window.


## A1.4.3 Calculating the Least-squares line

e) Calculate the least squares regression line.

The ouput screen from the previous section also includes the slope and intercept.

Note: Once the Set
Calculation window is closed by tapping $O K$, the least squares line will automatically be sketched in a Statgraph window.


## A1.4.4 Sketch Least-squares line

f) Sketch the least squares line. An alternative to the method seen above is:

To sketch the least squares line tap $\|_{\infty}^{\circ-}$ on the tool bar. (Or, select SetGraph from the menu bar, then Setting.)

Adjust the Set StatGraphs options. Leave StatGraph 1 as is and set up StatGraph 2 as shown. Tap Set.

Tap 6 on the tool bat.


## A1.4.5 Making a residual plot

g) Make a table of residuals and a residual plot.

In part e) you will have calculated the residuals and placed then in
list3.


To produce a residual plot, tap $\boldsymbol{u l l}^{\circ}$ :- on the tool bat. (Or, select SetGraph from the menu bar, then Setting.) Choose StatGraph3.

Adjust the Set StatGraphs options.

Untick the Draw option for StatGraph 1 \& 2.

Set StatGraph 3 to be as shown, be sure to select the residual list (list3) for the YList.

Tap Set.


Tap 5 liil on the tool bat.


## A1.4.6 Using the Least-squares line

h) Use your equation to predict the attendance on a day of maximum temperature at $23^{\circ} \mathrm{C}$ and compare your result to Day 17.

There are many different ways to achieve this - here is one method:

With the List Editor window active, select Calc from the menu bar, Regression, followed by Linear Reg.

Adjust the Set
Calculation options. (Be sure to change the Copy Formula setting to $y l$ and Copy Residual setting to list3.) Tap OK.


Tap $\sqrt[m a i n]{\alpha}$ on the icon panel.
Key in $y \mathrm{l}$ (23). Press EXE.
Solve the equation $y l(x)=27$.


## A1.4.7 Logarithmic transformation of data

Consider the following data stored as the variables 'time' and 'list2' respectively.

The graph of list2 vs time suggests the possibility that the variation may be described by an exponential function.


To transform, in the third column define a new variable ' $\operatorname{loglist2\text {'-anynamecanbeusedorsimplyuselist3.}}$

Tap in the Calculation cell at the bottom of this list.
Now type in the calculation you desire. Note that the full calculation is seen in the edit bar. Tap EXE].

Make a graph of the $\log ($ list2) vs time.



## Appendix 2 - Numerical Solver Application

This section assumes that the ClassPad is operating the
ax=b Numsolve application.

Note: While this application can be launched from the Menu it can also be from the Graph Editor, 3D Graph Editor and the Main application. Simply tap when in these applications.

Equations/formulae can be 'dragged and dropped' from the above mentioned applications into the Numeric Solver window.


## A2.1 Using the numeric solver

The volume of a cone, radius $r \mathrm{~cm}$ and height $h \mathrm{~cm}$, is given by: $V=\frac{\pi r^{2} h}{3}$.
a) Find the volume of a cone with $r=12 \mathrm{~cm}$ and $b=7 \mathrm{~cm}$.
b) Find the radius of a cone if $h=10 \mathrm{~cm}$ and $V=1500 \mathrm{~cm}^{3}$.

Tap in the equation: (Use the soft keyboards to enter the equation using natural input). Tap EXE.

The list of expression's variables will appear. Enter the values.

Enter the values of the variables you know and select the variable you want to find by checking the adjacent button.
Tap Solve on the tool bar.


Note that the Left-Right $=0$ refers to the value of the right hand side of the equation subtracted from the left hand side of the equation of the value of the variable computed. If this is 0 , then we confident the correct value of the variable has been computed.

The lower and upper bounds for the solution can also be specified. If the solution is not within the specified range, an error will occur - see opposite.

| $\%$ Edit Solve |
| :--- | :--- |
| Solve $\quad \psi \sqrt{\alpha}$ |
| Equation: |
| $\mathrm{V}=\frac{\pi \cdot \mathrm{r}^{2} \cdot \mathrm{~h}}{3}$ |
| $\mathrm{~V}=1500$ |
| $\mathrm{r}=$ |
| $\mathrm{h}=10$ |
| Lower $=0$ |
| Upper $=5$ |



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Notes

## ClassPad II

| Math1 | Line | 믈 | $\sqrt{\square}$ | $\pi$ | $\Rightarrow$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Math2 | $\square^{\square}$ | $e^{\square}$ | ln | $\log _{\square} \square$ | $\sqrt{\square}$ |
| Math3 | ｜ | $\mathrm{x}^{2}$ | $\mathrm{x}^{-1}$ | $\log _{10}(\mathrm{D})$ | Solve（ |
| Trig | प०］ | toDMS | \｛号 | （） | \｛ \} |
| Var |  |  |  |  |  |
| abc | $\sin$ | $\cos$ | tan | － | ＊ |
| $\triangle$ | 4 | 嫑 | E | ans | EXE |
| Alg | Standard |  | Real | Rad | 冝 |

Math1：The basics

| Math1 | Line | 믐 | $\sqrt{\square}$ | $\pi$ | $\Rightarrow$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Math2 | Define | 1 | $g$ | $i$ | $\infty$ |
| Math3 | Solve（ | dSly | ， | \｛ | I |
| Trig | ＜ | ＞ | （） | \｛ \} | ［］ |
| Var | ＜ |  |  |  |  |
| abc | $\leq$ | $\geq$ | ＝ | \＃ | $\angle$ |
| $\triangle$ \％ | 4 | 臨 | 嘍 | ans | EXE |
| Alg | Standard |  | Real | Rad | 血 |

Math3：Functions

| Math1 | $a$ | $b$ | $c$ | $d$ | $e$ | $f$ |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Math2 | $g$ | $h$ | $i$ | $j$ | $k$ | $l$ |
| Math3 |  |  |  |  |  |  |
| Trig | $m$ | $n$ | 0 | $p$ | $q$ | $r$ |
|  | $s$ | $t$ | $u$ | $v$ | $w$ | $x$ |
| Var | $y$ | $z$ |  |  |  | CAPS |
| abc |  |  |  |  |  |  |
| $\triangle$ | 4 | 霾 |  |  | ans | EXE |
| Alg | Standard |  | Real |  | Rad | 而 |

Mathematical variables

| Math1 | Line | 号 | $\sqrt{\square}$ | $\pi$ | $\Rightarrow$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Math2 | $\square^{\square}$ | $e^{\square}$ | ln | $i$ | $\infty$ |
| Math3 | $\square$ | $\frac{\mathrm{d}}{\mathrm{d}} \mathrm{\square}$ | $\frac{\mathrm{d}}{\mathrm{d}} \mathrm{\square}$ | $\int_{\square}^{\text {口 }}$ | $\lim _{\square \rightarrow \square}$ |
| Trig | ［ 1 ［］ | ［吕］ | ［맘］ | 呂口 | Пワ |
| Var |  |  |  |  |  |
| abc | $\sin$ | $\cos$ | tan | $\theta$ | $t$ |
| $\triangle$ | 4 | 礵 | 5 ${ }_{\text {㫛 }}$ | ans | EXE |
| Alg | Standard |  | Real | Rad | 而 |

Math2：Moving on

| Math1 | Line | 号 | $\sqrt{\square}$ | $\pi$ | $\Rightarrow$ |
| :---: | :---: | :---: | :---: | :---: | :---: |
| Math2 | sin | $\cos$ | tan | $i$ | $\infty$ |
| Math3 | $\sin ^{-1}$ | $\cos ^{-1}$ | $\tan ^{-1}$ | $\theta$ | $t$ |
| Trig | $\sinh$ | cosh | tanh | － | r |
| Var | sinh |  |  |  |  |
| abc | $\sinh ^{-1}$ | cosh ${ }^{-}$ | $\tanh ^{-1}$ | $\square^{\square}$ |  |
| $\triangle$ | 4 | 䭆 | 5 | ans | EXE |
| Alg | Standard |  | Real | Rad | 血 |

Trigonometric functions


QWERTY keyboard

