

Introducing *MathView*

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What is *MathView*?

MathView is a program for doing mathematics. More formally, *MathView* is a Computer Algebra System, meaning it can manipulate mathematical equations and expressions in a symbolic or algebraic manner. This feature sets *MathView* apart from other programs or, for that matter, most calculators, which require you to use numerical values.

Real mathematical notation... $x^2 dx$

Command-line notation... `Int (x^2, x)`

MathView is different from other Computer Algebra Systems because of its unique graphical interface and the way it displays both inputs and outputs. When you enter equations, *MathView* displays the inputs in real mathematical notation, as opposed to a command-line display. After you manipulate equations and *MathView* generates the answer, the answer also is displayed in real mathematical notation.

Do not worry about trying this example at this time. The remainder of the guide will show you step by step, how to input and solve equations as well as how to generate graphs.

MathView allows you to manipulate equations: by using menu selections; by clicking on Palette icons; or by invoking command key equivalents. Take, for example, the following problem where the goal is to solve for y , and then generate a graph.

$$\square -2x = -\sin(x^3) - x^2 + y$$

You solve by first selecting y , and then clicking on the **Isolate** icon (on the top row of the Palette).

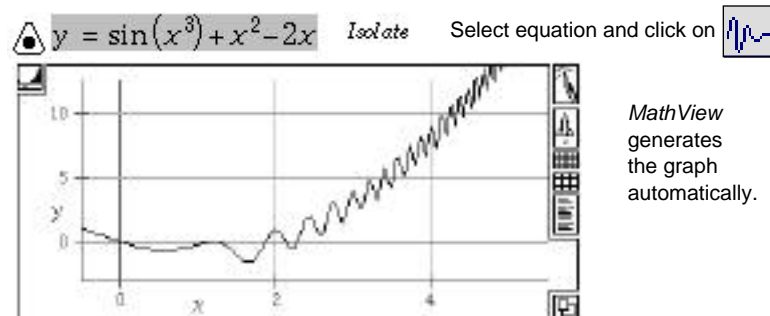
$$\square -2x = -\sin(x^3) - x^2 + y \quad \text{Select } y \text{ and click on } \text{Isolate}$$

MathView solves the equation for y .

$$\square -2x = -\sin(x^3) - x^2 + y$$

$$\triangle y = \sin(x^3) + x^2 - 2x \quad \text{Isolate}$$

Graphing the equation is as easy as selecting it and clicking on the linear graph icon on the Palette.



MathView generates the graph automatically.

You can save or print your *MathView* documents, send them via e-mail to a colleague that uses a different platform, or copy parts of them to other documents. In addition, you can annotate your workspace with words and pictures as well as produce animations.

How to Use this Guide

The objective of this guide is to show you how to use *MathView* through examples. The guide starts out showing how to install the program and then presents a comprehensive example (see “Starting Example #1” on page 16). This example is for everyone, even for those who do not like to read manuals. It gives you a good first look at *MathView*, and provides a foundation for further exploration. This example may be all that you require; if so, you can use the remainder of the guide as a reference. For some, the reading and working of the examples which remain will be the way to go.

After the first example, the chapter called Preliminaries (page 27) covers the most important and basic *MathView* manipulations and procedures.

After Preliminaries, the approach changes. Starting with the chapter called Functions (page 97), the guide introduces *MathView* manipulations by including them in familiar mathematical subjects. Each section starts with a list of *MathView* skills and commands that the section features along with a short introduction. The chapter then presents examples demonstrating those skills.

After you have mastered the basics of *MathView*, you will find the table of contents, the appendix, and the index valuable guides in directing you. If you have a question about the use of a menu or palette item, go to the index and find where in the guide an example demonstrates the skill.

Most of the examples are of an analytical nature, with little real world application. For example, you will look at slope as a subject in its own right, without discussion of its application in the areas of velocity and acceleration. The guide, for the most part, does not teach the mathematics, but how to use *MathView* to solve mathematical problems.

- A bullet precedes the steps you are to follow in examples. Commentary is formatted like the rest of this page.

MathView is a mathematics engine, in the same way some consider a spreadsheet program an accounting engine. Both start out with a blank document where you enter problems and use the program tools to solve those problems. *MathView* can help you solve all but the most advanced mathematics. You can use it for mathematics curriculums found in high schools and all the way through most undergraduate programs; if you are a scientist or an engineer you will find *MathView* an invaluable tool.

MathView has many powerful tools, unavailable in other programs, that can help you understand the math. Your imagination is your only limitation.

Besides this guide, many *MathView* resources are available to you. Several books on the use of the program are available, and if you can connect to on-line services, you will find a network of people and resources available that can enhance the usefulness of the program. To find updated information, connect to the Waterloo Maple web-site (<http://www.mathview.com>).

Many have said that, in this computer age, learning and using mathematics will never be the same. Once you learn how to use *MathView*, you will see why.

Installing on a Macintosh

The following preparation instructions apply to all Macintosh System versions. Do not follow these instructions if you are using a computer with Microsoft Windows. See page 8.

Serial Number

Please take note of the serial number on the cover of the CD and on your Registration Card. You need this number to install the program and when upgrading.

System Requirements

- *MathView* works on a Macintosh Plus (68030 processor), or later model Macintosh. (An older Macintosh upgraded to the equivalent of a Plus is satisfactory.)
- The minimum memory requirement for the *MathView* program alone is 2.0 Mb RAM, although 3.0 Mb is suggested.
- You must have a hard disk with at least 3 Mb of free space for *MathView* and its related files.
- *MathView* is supported on System 7.1.1 or later.

Symbol Font and Greek Letters

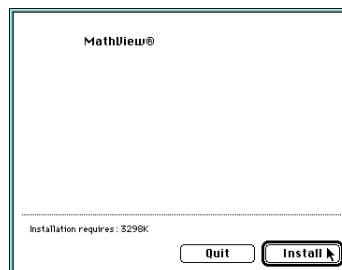
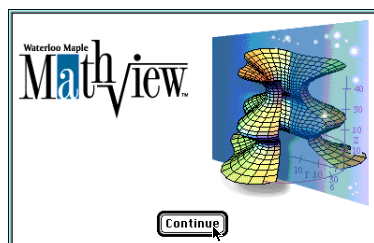
In order for you to use Greek letters and other symbols in equations, you must have the Symbol font installed in your System. The Symbol font comes with all of Apple Computer's system versions. Follow the Macintosh documentation to learn how to install it on your System.

MathView Application Installer

All you have to do to install *MathView* onto your computer is to double-click on the installer icon (called MathView Installer). The installer will check for the type of CPU you are using and install the appropriate version.



Two dialogs will open in order below. When you click on the first one, the installer will start its process. The second dialog tells you how much disk space the program will take up on your disk. Click on the **Install** button or press . There is another installer, the *MathView* Internet Installer. This file is discussed in

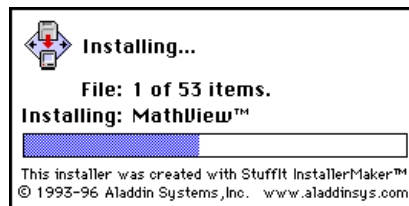


the section; "MathView and the Internet" on page 213.

The installer will open the following dialog box, giving you the opportunity to choose the location on your disk of the *MathView* folder.

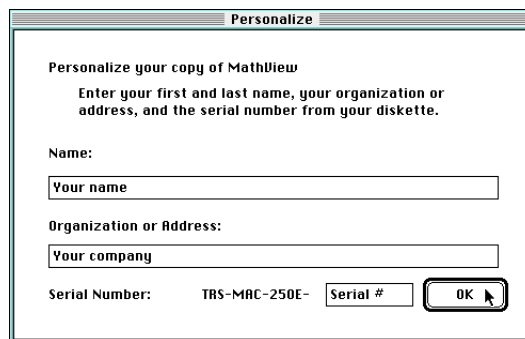


After you have chosen the location and have clicked on the **Install** button or pressed **return**, the installation will proceed. The following progress box will display on your screen as the installer expands the program



The next box that opens is the personalization dialog. Fill in your name and your organization in the appropriate boxes, along with your serial number. Enter the rest of your serial number exactly as it appears on your registration card. Click on the **OK** button or press **return**.

Warning:
You must have a name
and organization with at
least 6 characters.



The *MathView* installer will close down and unlock the program. If you type in the wrong serial number or do not use names with at least six letters in them, you will be alerted and the program will close down. Open the program back up, by double-clicking on the *MathView* program icon, and enter the information again.

Program Icon



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Web-Browser Plugins

There is an internet browser plug-in called *MathView Internet* on the *MathView* CD. *MathView™ Internet* is a web-browser plug-in designed for use with browsers such as Netscape™ Navigator, Microsoft Internet Explorer, or Cyberdog. To install, follow the instructions in the ReadMe file contained in the folder labelled “MathView™ Internet”. See “MathView and the Internet” on page 213 for more information.

Notebooks Folder

The folder called Notebooks which the installer places in your *MathView* folder contains several special notebooks for your use. They contain examples and are configured to special topics.

New Notebook

The document called New Notebook is a *MathView* file which acts as a type of stationery pad. Each time you open *MathView* by double-clicking on the program icon, this specially configured file will open as an Untitled document. Also when you choose **File ▶ New Notebook**, this file will open as an Untitled document.

Using the Application

To open the *MathView* application from the Finder, double-click on the *MathView* icon.



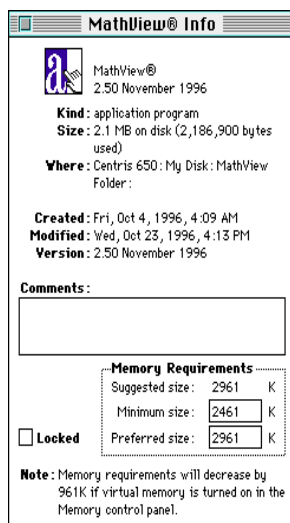
Closing the Application

To stop using *MathView*, choose **Quit** from the **File** menu. *MathView* may ask you to save open files.

Increasing Application Memory Size

To create large notebooks and QuickTime animations, you must increase the *MathView* application memory size. First, close *MathView*. Now, select the application in the Finder and choose **Get Info** from the **File** menu to bring up the Info dialog.

This dialog looks slightly different under different System versions.



Installing on a Macintosh

The box in the lower right hand corner labelled "Preferred size" specifies the amount of memory you want available to the application. Enter the number of kilobytes you prefer and close the window.

Memory Requirements		
Suggested size:	2965	K
Minimum size:	<input type="text" value="2465"/>	K
Preferred size:	<input type="text" value="2965"/>	K

Installing on Windows

The following preparation instructions apply to computer systems with Microsoft Windows. Do not follow these instructions if you are using a Macintosh computer (see page 4).

Serial Number

Please take note of the serial number on the cover of the CD and on your Registration Card. You need this number to install the program and when upgrading.

System Requirements

- To run *MathView*, you must have a computer with an 80386 or later CPU running Microsoft Windows (version 3.1 or later in enhanced mode), Windows 95, or Windows NT.
- You must have at least 2 Mb of RAM and 3 Mb of free hard disk space available for *MathView* and its related files.

Symbol Font and Greek Letters

In order for you to use Greek letters and other symbols in your equations, you must install the Symbol font for use with Windows. All Microsoft Windows versions have the Symbol font.

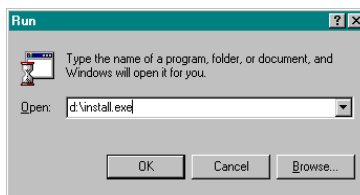
Follow your Windows documentation to learn how to install the font on your system.

Installing *MathView* on a Windows System

These instructions show screen shots of a Windows 95 installation. They also assume the hard drive is the c: volume and the CD drive is the d: drive.

Insert the CD into the drive.

With your computer currently running Windows, close any open applications. From the Windows Program Manager's File menu (Windows 3.1 or Windows NT), or the Start menu (Windows 95), choose **Run**. In the Command Line box (Windows 3.1 or Windows NT), or the Open box (Windows 95), type **d:\install.exe**



Using the Install Program

The Install program starts up and shows the following dialog.



The installer will create a new directory named *MathView* at the path the dialog specifies. If you want a different name or a different directory, type a new path-name in the box.

Exit Install

If you do not wish to install *MathView* at this time, choose **Exit Install** to leave the install program and return to Windows. If you stop the installation process, no files will be installed on your disk.

Continue Install

Click Continue to install *MathView*.

Copying Files

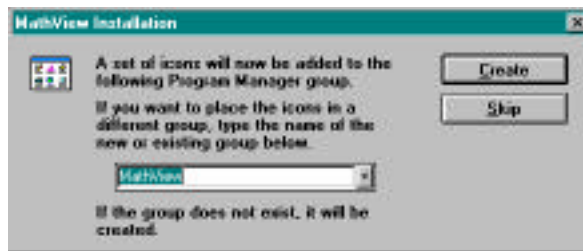
When you continue with the installation, the install program decompresses and copies various files to the specified directory and informs you of its progress.



Creating a Group

After you copy the files to your hard disk, the Install program asks whether you want to create a *MathView* group or skip it.

You may type another name for the group.



Unless you are re-installing *MathView* and already have a *MathView* group, click Create.

Exiting the Installer

When the installer finishes, it returns to Windows, where the *MathView* group is open for you.

Personalizing Math View

Double-click the *MathView* application icon from the *MathView* group in Windows (or choose the *MathView* item from the Program section of the Start menu in Windows 95) to run *MathView*.



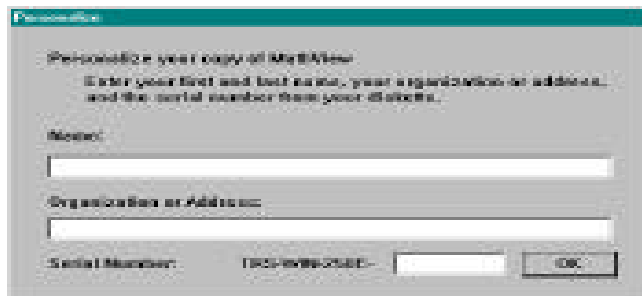
The first time you open the program, a dialog appears for personalizing your copy of *MathView*. Enter your name, organization, and serial number in the places provided. You can find the serial number on the cover of the CD and on your Registration Card. Enter the rest of the serial number exactly as it appears on your

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Registration Card. When you have completed the information click **OK** or press

.

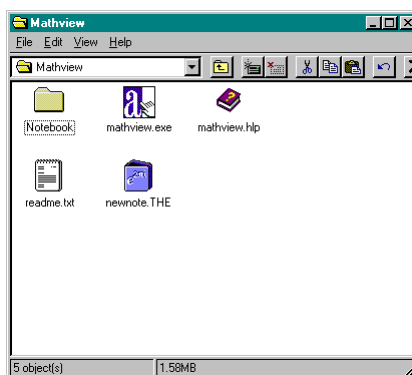
Warning:
You must a name and organization with at least 6 characters.



After you have done this, *MathView* will close down and unlock the program for your use the next time, and all subsequent times you open *MathView*. If you type in the wrong serial number, or do not use names with at least six letters in them, you will be alerted and the program will close down. Open the program back up, by clicking on the *MathView* program icon, and enter the information again.

Using the Application

Double-click the *MathView* icon to open the *MathView* application.



Closing the Application

Choose Exit from the File menu to stop using *MathView*. *MathView* may ask you to save open files.

Writing Conventions

For the most part, the examples in this guide are independent of each other. This means that once you have read and understand this introductory chapter and the chapter called Preliminaries, you can just select a topic of interest from the contents and go directly to it. This guide is your introduction to *MathView*. It discusses the most important concepts and builds a framework of knowledge which you can then expand upon depending upon your needs.

The guide assumes you have a basic knowledge of the mathematics. Numerous areas do exist, however, where you will review the underlying mathematical concepts to help you make the link between the old methods and the new computer methods. You will find *MathView* useful whether you are a beginning student of mathematics, or a scientist or engineer who needs to analyze the most complicated equation.

Help

The Windows version has a separate on-line help system, that you access from the Help menu. You access help with the Macintosh version by using Apple's Balloon Help.

Anomalies

This guide uses screen-shots of Macintosh windows and dialogs which may have a slightly different appearance than what you will see on your screen, depending on the platform and font you are using. The font you see in the screen-shots is Adobe's *New Century Schoolbook* (italics on).

All versions of *MathView* are virtually the same except for the location and appearance of the main menu (at the top of the screen in the Mac and at the top of the Notebook window in Windows). Command key equivalents are different too, depending on the platform. All manipulations are the same, and notebooks in one platform are 100% compatible with other platforms.

Fonts used in this Guide

Courier font represents input in the beginning. After the first section, it is mixed with other styles. For example, when instructed to input *sin(x²)*, you will know that you type;

The body of the guide uses the Times font. The five other fonts in the guide help you link what you see in the guide to what you see on your screen.

- **Chicago:** Denotes menu selections and dialogs. For example, **Manipulate ► Simplify** tells the reader to select the menu item Simplify under the Manipulate menu.
- **Courier:** Instructs the reader what keys to press to input equations to the workspace. For example, when you type: **sin(x^2)** the result will be the following:

$$\text{sin}(x^2)$$
- Helvetica 8pt: Notates screen shots and side-column notes.
- **Helvetica 18 and 10pt Bold:** Main section and side headings.
- **NC Schoolbook:** Variables and some dialog text, in the body of the guide.

Screen Shots

The guide displays equations in the *New Century Schoolbook* font captured from Macintosh notebooks (using a screen-shot utility). Because equations and graphs, in some cases, are scaled down to fit in a particular area, they may appear smaller than what you see on your screen.

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Highlighted areas on your screen may be colored depending on how you have set your system.

Many times, screen-shots are of only part of the whole Theory (a Theory is a group of related mathematical propositions). Therefore, your workspace may show more than what the guide shows. In addition, some of the screen-shots show manipulations which only temporarily display on your screen. On occasion, the guide shows what you will see during these manipulations.

A picture of the cursor in the screen-shot normally indicates where a selection occurs or where a mouse click occurs.

Expressions the guide highlights in gray, in most cases, show the selected portions of the equation before you invoke the manipulation. In most, *but not all*, cases the guide shows highlighted results, too, because *MathView* highlights results after manipulations occur.

Manipulations

You will manipulate equations by using one of four methods: by menu selection; by Command key action; by clicking on Palette icons; and by using the “Hand” (see section to follow). The **Chicago** font notates menus, with arrows designating sub-menus. Thus, the Auto Simplify Preference item, is noted as **Manipulate ► Manipulation Prefs ► Auto Simplify**. This means that you let go of the mouse after you have navigated to **Auto Simplify**. Do this by dragging the mouse to the **Manipulation Prefs** choice under the **Manipulate** menu. A sub-menu will open so you can drag the mouse to **Auto Simplify**.

MathView provides you several methods of performing manipulations. The guide will attempt, in the beginning, to describe most of these to you. As you progress, however, the guide will only mention one or two of these methods. In most cases, the manipulation method you use is a personal choice.

The guide does not discuss the use of the Command key equivalent keystrokes in the main body of the text because they are not the same on all platforms. You will find a list of most of these in the appendix. The menus also display many of these next to the commands. You may want to make a list of Command key keystrokes to have next to your computer as you learn. Many of them will become the method of choice for your manipulations.

Side Column Icons

Palette image of
Linear Graph

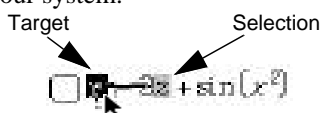



Icon images in the side column represent Palette methods. They are there to remind you that you can click on the same image on the palette to achieve the results described in the text. For example, you generate a linear graph by selecting the menu choice: **Graph ► y = f(x) ► Linear**. The icon in the side column to the left of this paragraph indicates that you can click on this palette image to perform the same action.

Hand Manipulations



MathView allows you to move variables and expressions around the screen by invoking the “Hand” cursor. In some cases, the guide will show the expression or equation in the middle of one of these manipulations. That part of the expression in gray is the selection and that part in reverse video is the target. Reverse video is white-on-black in this guide, white-on-color on your screen if you have chosen a background color for your system.



Keyboard Actions	The guide notates keyboard actions in one of two ways. The first is to write out the action, as in, “press the Return key”. The second is to show an image of the key itself  , which has the same meaning .
Examples	<ul style="list-style-type: none"> • Bulleted, indented paragraphs indicate the steps of examples.
Space key	Blank spaces may appear to be included in example input. Do not include a space (by pressing the Space key) in your inputs unless specifically directed to do so with the words “press the Space key” or “press ”. Pressing the Space key (or if you prefer, Space bar) is a special short-cut in <i>MathView</i> for multiplication. For the most part, examples will display the asterisk (*) to denote multiplication. You can use the Space key short-cut rather than typing an asterisk for most, if not all, multiplications.
Notes	Text in the side column are notes that contain additional information about the current subject.
Teacher’s Notes	These areas discuss teaching tips.
Return key	The Return key on many DOS machines is labeled Enter. If you are using the Windows version of <i>MathView</i> , when requested to press the Return key, this means that you should press the Enter key on the main keyboard. In all versions, the Enter key on the numeric keypad has a totally different function (see page 17).
RHS/LHS	LHS and RHS are abbreviations for the Left Hand Side and the Right Hand Side of the equation respectively.

$$\boxed{x^2 + y^2} = \boxed{2xy}$$

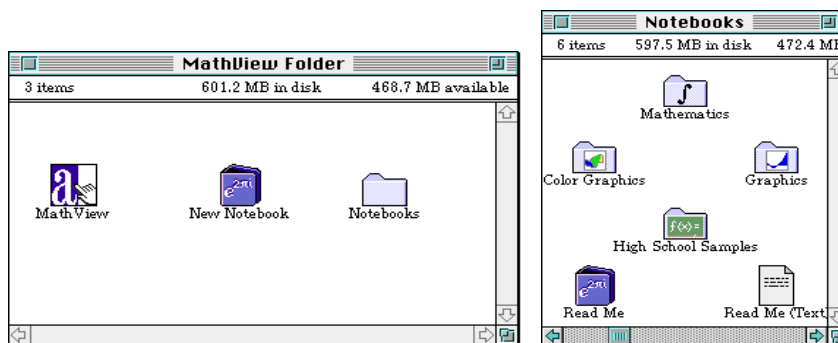
LHS RHS

A First Example

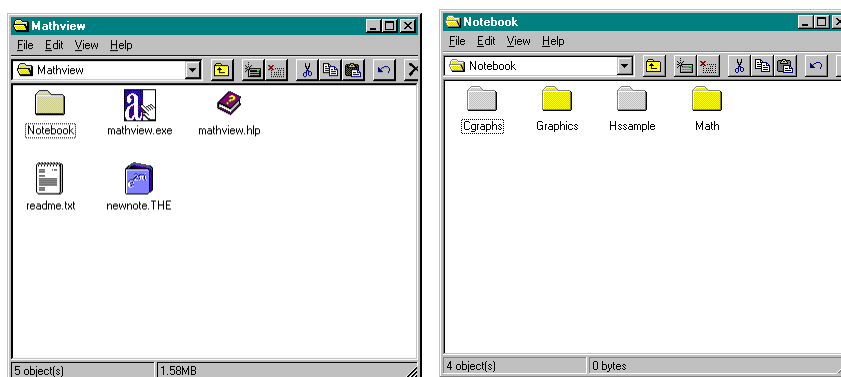
This example is for those of you who want to get right to work and would prefer to read the guide after a little experimentation. Followed very carefully, this example should give you a good start. After you complete the example, you are encouraged to continue on in this guide in a sequential manner, or you can go to individual subject areas.

Desktop

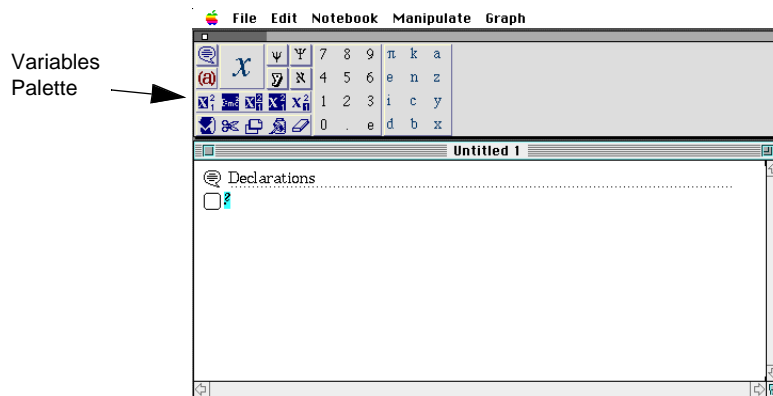
After installation, you will see the following images on your desktop. For the Macintosh, depending on where you have chosen to place the files, your window should look similar to the following.




The Windows desktop will look something like the following.

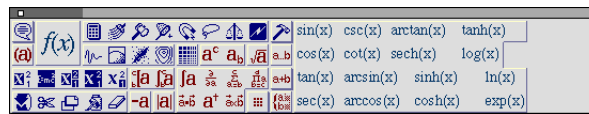


- Opening MathView** • To open a *MathView* document on a Macintosh, double-click on either the program icon or the notebook called “New Notebook”. A document will open which looks like the following.



The Palette showing is the Variable Palette. If you click on the large x , it will change to the Function Palette.

Click on this  and the Palette changes:



When you open the Windows version by double-clicking on the program icon, or by clicking on the notebook called “Newnote”, the following window will display. Below is the Function Palette which you obtain by clicking, again, on the x in the Variable Palette.



Function Palette






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Starting Example #1

The screen-shots in the examples are taken from the Macintosh version. They apply to the Windows version as well, but may look somewhat different on your screen.

Notice that you have a highlighted ? in your Notebook. *MathView* opens the document ready for input.

- The ? is highlighted (if not, select the ? by clicking on it). Type the following.  means press the Escape key.

$$2 * x^2 \text{  } + 11 * x + y = x^3 \text{  } + 12$$






The Result is:

$$\square 2x^2 + 11x + y = x^3 + 12$$

You have entered a Proposition (abbreviated in the guide as Prop).

- To show an alternative way to input the equation, select the Proposition by clicking once on the rounded square icon to the left and press *f*.

This time you will use the Palette to input the same equation.


- Click on the **2** on the Variable Palette.
- Select the multiplication operator inside the **a+b** Pop-up menu on the Function Palette (**a•b**). A ? will appear awaiting an input.
- Click the Superscript icon on the Function Palette. 
- Click on an **x** on the Variable Palette.
- Click on the superscript ? to highlight it, and click on **2** on the Variable Palette.
- Click on the **Select out** icon  3 times to highlight the $2x^2$. and select the addition operator inside the **a+b** Pop-up menu.
- Click on **1** twice, choose the multiply operation again (**a•b**), and then click on the variable **x**.
- Click once on the **Select out** icon  and select **a+b**. Click on **y**.
- Click on **Select out** once  to select the whole expression.
- Choose the **a=b** operator under the **a+b** Pop-up menu and click on **x**.
- Click on the Superscript icon again 
- Click on **3**, click **Select out** twice, and choose the addition operator (**a+b**).
- Click on the number **1** and the number **2**.

This method looks tedious on paper, but as you learn all of the ways to input expressions, you will find this method very useful for much of your input.

- In order to graph this equation you must isolate, or solve for, **y**. You can do this in one of three ways. Each requires you to select **y** first. Do this by dragging the mouse across **y** or double-clicking on **y** until it highlights.



Notice that when you start inputting, a new Prop with a ? automatically appears.

You can also generate a new Prop by pressing .

Isolate

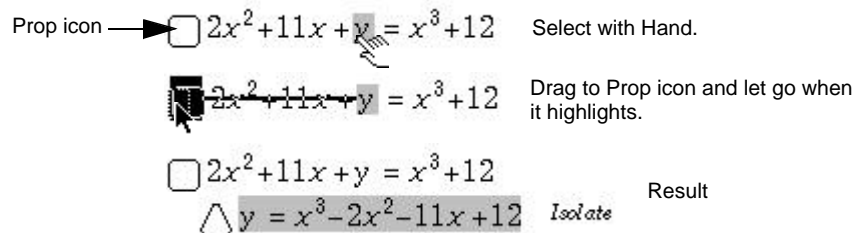


Try each method by choosing **Undo** under the **Edit** menu after each manipulation.

Make sure you get the pointer all the way over and into the Prop icon. If you do not make it all the way, you will be doing a **Commute** manipulation. **Undo** will let you start over if you make this mistake.

The first method is to choose **Isolate** under the **Manipulate** menu. The second method is to click on the **Isolate** icon on the Functions Palette (the icon in the column to the left of this paragraph).

The third method is to use the “Hand” cursor to drag the **y** over to the Prop icon. After you select **y**, move the mouse over it. Hold down the \square key (Macintosh) or the \square key (Windows). The cursor will turn into a Hand. Press down on the mouse button and, while continuing to press down, drag away (you can let up on the key now). A dotted outline will follow the mouse around the screen. Move the mouse cursor to the Prop icon and let go. This action isolates **y**. Below are three screen-shots showing the selection, the manipulation, and the result.



Results have a rounded triangle shaped icon in front of them. A rounded triangle indicates that the result is a conclusion to a manipulation. **Assumptions** are inputs (rounded square icons), and **Conclusions** are answers (rounded triangle icons), which result from a *MathView* manipulation. Notice the word **Isolate** to the right of the result. After every Conclusion, *MathView* displays the manipulation that caused the result. You can turn this feature off by choosing **Show Steps** under the **Notebook ▶ Notebook Prefs** menu. To turn it back on, choose it again; it toggles on and off each time you choose it. **Show Steps** is a global command, meaning that it affects all of the manipulations in the notebook.



- While the equation is still highlighted, choose **Copy** under the **Edit** menu.
- Select the first Prop by clicking once on the square icon (this action selects the Prop and the equation) and choose **Paste**. *MathView* generates a new Assumption Prop, (preceded with a rounded square icon) below the two original Props containing a copy of the conclusion. This step demonstrates how you can use the results of a manipulation in a new problem.
- The original Prop is not necessary now, so select it by clicking once on the rounded square icon in front of the equation and press **f**. Remaining will be the newly manipulated equation.

$\square y = x^3 - 2x^2 - 11x + 12$ Manipulated equation in explicit form

If you give **x** a value, what is **y**?

On DOS machines, you press the Enter key on the main keyboard.

- Press \square , to generate a new Assumption Prop, and type $x = 3$. Select this new equation by clicking once on the equal sign and move it, with the Hand, to the Prop icon of the **y** equation and let go. This action will substitute the

value of 3 into all occurrences of x in the equation.

$y = x^3 - 2x^2 - 11x + 12$
 $x = 3$

Select $x = 3$ and with Hand move to Prop.

$y = x^3 - 2x^2 - 11x + 12$
 $y = -12$ *Substitute*
 $x = 3$

Result

- To demonstrate **Always ReManipulate**, select the 3 in the $x = 3$ Prop and change it to a 5. **Always ReManipulate** works like a spreadsheet with auto-calculate turned on, it recalculates the result. You can turn this feature on and off by choosing **Always ReManipulate** under the **Manipulate** menu. To invoke a **ReManipulate** when you have **Always ReManipulate** turned off (no check mark), choose **ReManipulate Now** under the **Manipulate** menu.

$y = x^3 - 2x^2 - 11x + 12$
 $y \neq -12$ *Substitute*
 $x = 5$

In the process of changing

$y = x^3 - 2x^2 - 11x + 12$
 $y = 32$ *Substitute*
 $x = 5$

Result

- You do not need this manipulation now, so select the $x = 5$ Prop (click on the icon) and press f . Since the manipulation has no source now, *MathView* turns the Conclusion into an Assumption (see “Divert Cascade” on page 218 to see how to reconstitute this Theory). For now, just press f again. The original Prop remains.

When you have **Always ReManipulate** checked off, you can have *MathView* re-manipulate individual Props by clicking anywhere inside the equation of the one you want re-manipulated. The selected equation and all Props which lead to the remanipulation re-calculate. All Props under, or after, the selected equation remain un-calculated.

RHS means the right-hand side of the equation.



One way to find the roots of this equation is to factor the expression on the RHS, set y equal to zero, and solve for each x .

- Select the RHS by double-clicking on one of the operators (either a + or a - sign).
- Choose **Factor** under the **Manipulate** menu. When the dialog box appears warning that it may take a long time, click on the **Yes, go ahead** button, or press .

$y = x^3 - 2x^2 - 11x + 12$
 $y = (x-4)(x+3)(x-1)$ *Factor*

Result

- Create a new Prop and enter $y=0$. Substitute this equation into the equation above, then select each x in the resulting Conclusion separately and **Isolate**.

$0 = (x-4)(x+3)(x-1)$ *Substitute*
 $x = 4$ *Isolate*
 $x = -3$ *Isolate*
 $x = 1$ *Isolate*
 $y = 0$

Linear Graph 

MathView has a root finder that you can use when you plot the function.

- Select the last Prop and press *f* until the original equation remains. Click anywhere inside the equation (you do not have to select the whole equation), and choose **Graph ▶ $y = f(x)$ ▶ Linear**.



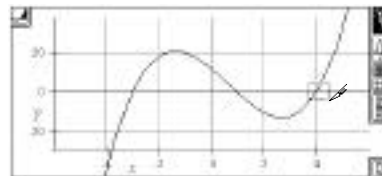
- To see more of the graph, zoom out once by clicking on the Rocket ship. The plot will zoom out by a factor of two each time you click on it.

To find the roots, you need to zoom in on the *x*-intercepts (where the line crosses the *x*-axis).

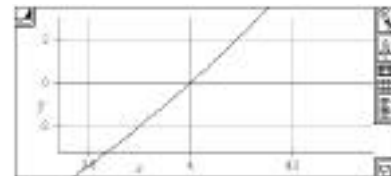
- Click once on the Knife and move the mouse into the Viewport and select a root by clicking to the left and above one of the *x*-intercepts. While you still have the mouse depressed, drag down and to the right, creating a dotted rectangle defining a new view. Let go of the mouse and watch the graph re-draw, showing only the area defined by the dotted rectangle.

Viewport is the term the guide uses to refer to the visible area of a Graph Theory containing the plot.

Select with Knife




Result




Do not perform any other action between the generating of the root and the **Undo**. If you make a mistake, delete the graph by clicking on the Graph icon at the upper left of the graph and press *f*. Now start over.

- Choose **Find Graph Root** under the **Manipulate** menu. This action generates a self-contained Case Theory defining the value of *x* at $y = 0$.
- To find the other roots, select **Undo** under the **Edit** menu. The graph goes back to its original view. Perform the manipulation again at a new crossing. The **Undo** will not affect the Case Theory containing the first root.

You can generate a table to further study this function. You must first create a Case Theory so the work you do with the Table will not conflict with the other work in the Notebook.

- Select the last Prop in the Notebook by clicking on its leading icon. Press  to generate a new Assumption Prop, and choose **Case Theory** in the **Insert** sub-menu under **Notebook**. *MathView* surrounds the Prop in a box with a circle icon, indicating that it is now a Case Theory.

You can notate this area by giving it a descriptive title.

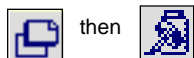
- Press the Enter-key  (on the numeric key pad). The square icon turns into

You can change the action of the Return and Enter keys by selecting **Edit ▶ Editing Prefs ▶ Enter Key...**

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a balloon icon indicating that it is now a text area. The cursor should be blinking next to the icon. If not, click the mouse in that area.

Type, **Generating a Table using the function:**



- Press **return** to create a new Assumption Prop.
- Go up to the first Assumption Prop in the Notebook and select the function again by clicking once on its equal sign. Select **Copy** and then **Paste** it to the new Prop inside of the Case Theory. Make sure to select the **?** before you **Paste**.



- Select the equation again and choose **Edit ► Copy as Picture**. Click just to the right of the colon in the text area and **Paste**. *MathView* copies the equation, in real mathematical notation, to the comment area.

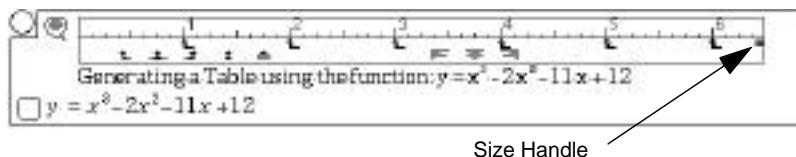
You can control the appearance of your comments, including their size, by using the Comment Palette area.



- Click on the balloon icon in the upper left of either the Variables or the Functions Palette and hold down the mouse button. The following pop-up menu will display.



By sliding the mouse over to the ruler icon just to the right of the balloon and letting go of the mouse, a ruler allowing you to adjust the tabs and size of the comment area will open in each Comment area.



The largest Prop in the Theory determines the width of Case Theories. In this case, the largest Prop is the comment, even though the text does not fill the comment area. By reducing the width of the comment, the outline of the Case Theory will shrink.

- Since this comment area may be too large to fit on your screen, click on the size handle on the right of the ruler and slide it over to the left. The comment will wrap to the next line if the ruler is shorter than the existing text.

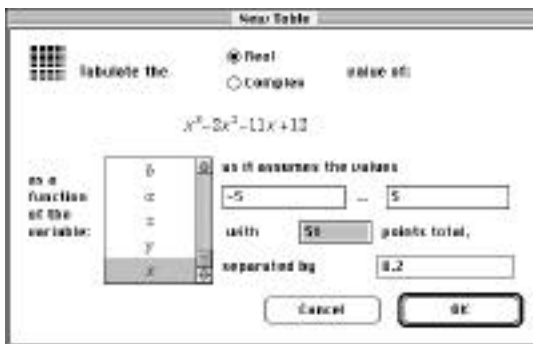
The other items in the Comment editor allow you to change the type and style of the font, along with the color of the font. This Palette Pop-up menu allows you to change small areas of a particular comment. To globally change the comment areas, and to change the font characteristics of equations, you choose **Notebook Font...** under the **Notebook** menu.

- Select the ruler icon in the Comment Palette area again and the rulers will disappear.
- Select the RHS of the equation, and choose **Generate...** under the

Remember, the icons in the side column are to remind you that you can click on the Palette icon to perform the same operation as indicated in the text.



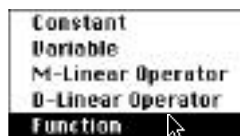
Manipulate ► **Table** menu. When the New Table dialog opens make sure you have selected **x** as the variable and change the value range from **0 ... 6.3** to **-5 ... 5** with **51** points. Press **[return]** or click **OK** to generate the Table.



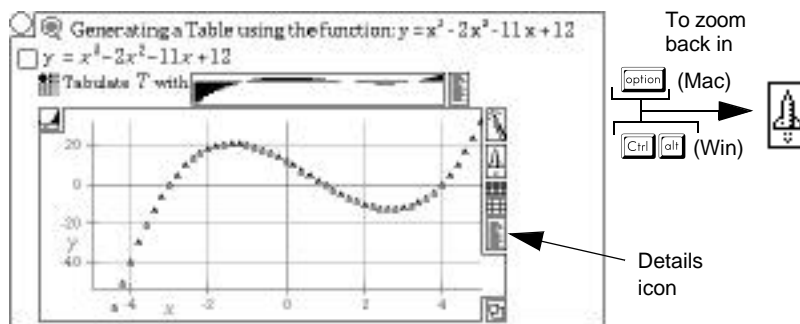
To generate a Graph Theory using the data points in the Table, you must give the table a name.

Clarify causes *MathView* to check the whole notebook for undeclared variables and will redraw plots.

- Click on the **?** in the phrase, "Tabulate ? with..." and type a **T**. Clarify the Notebook by choosing **Clarify** under the **Notebook** menu and declare **T** a User Defined **Function**. Hold down the mouse button on **Variable**, drag down to **Function** and let go. Finish by pressing **[return]** or clicking on the **User Defined** button.



- Select the Table by clicking once on its icon and generate a plot by choosing **Graph** ► **Scatter** ► **Linear**. Choose **x** as the **x-axis** variable and **y** as the **y-axis** variable leaving the **n parameter** as arbitrary. Press **[return]**.



Zooming out, by clicking on the rocket, shows the domain limitations when you created the table (-5..5). Zoom back in by holding down the **[option]** key (Macintosh), **[alt]** and **[Ctrl]** (Windows), while clicking on the Rocket Ship.

- So that you are looking at the same plot as above, open the graph details by clicking on the Details icon and change the Viewport to the following. Select

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Details opened



Details closed



each number without selecting the attached minus signs and type the numbers shown below.

-3.5 ... 5 = left...right Stretch to Fit ▼
 -20 ... 25 = bottom...top cropping Moderately ▼

Below the Viewport are the Scatter Plot details. Experiment changing the style of the markers by clicking on the pop-up menus and choosing different styles and colors. You can change the Viewport itself by selecting different items in the pop-up menus above (**Stretch to Fit** and **Moderately**).

Click on...



to select the table

- Change to Red Squares and close the details by clicking on the Details icon again.
- Plot a line on top of the data by selecting the Table and choosing **Add Line Plot** under the **Graph ► Additional** menu. Choose **x & y** as the axes and press **return**. Open the Graph details again and change the Line detail to match the following. Change the domain of the line from **Left...Right** to **-2...4**, and the line weight from **normal** to **heavy** . Close the details.

-3.5 ... 5 = left...right Stretch to Fit ▼
 -20 ... 25 = bottom...top cropping Moderately ▼

Declarations

Scatter plot of $(-5+0.2k_{101}, T[-5+0.2k_{101}])$ where $k_{101} = 0 \dots 50$
 using 5 point squares colored Red

Line at $(x, T[x])$ where $x = -2 \dots 4$ with a heavy line, colored Black

← Line Detail

The Graph Theory will reflect any change you make to individual points in the table. First move the Table to below the Graph Theory for better viewing during this operation.



- Select the Table by clicking on its leading icon and drag to below the Graph Theory with the Hand, using the same method you used to move variables earlier in the example. When you are in the right location, a black square highlights the area. Let go of the mouse.

Generating a Table using the function: $y = x^3 - 2x^2 - 11x + 12$

$y = x^3 - 2x^2 - 11x + 12$

Tabulate T with

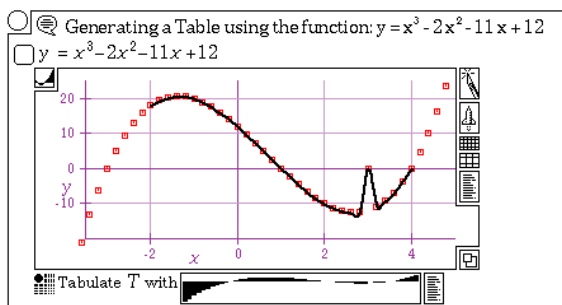
← Select Table

← Move to below Graph

- Open the Table Details by clicking on its Detail icon and change the **T(3)** value from **-12** to a value of **0**. You will need to scroll your screen down a bit.

$$T(3) = 0$$

The Case Theory will look like the following after you have closed both Details.



You can extract individual values from the table by setting up a Prop defining a function.

- Select the Table and press to create a new Assumption Prop.
- Type $y =$, click on the Palette image of $T(x)$ (on the Functions Palette) and type an x .
- Press and type $x = 5$

$$\begin{aligned} & \square y = T(x) \\ & \square x = 5 \end{aligned}$$

- Select the $x = 5$ equation by clicking on the equal sign, and this time hold down the Shift key while selecting the x in the function. The method of selecting more than one item at a time is called Shift-Clicking.

$$\begin{aligned} & \square y = T(x) \\ & \square x = 5 \end{aligned}$$

- Choose **Manipulate** ► **Other** ► **Substitute**. Declare T a User Defined Function when the dialog box opens.
- After the substitution has occurred, select the RHS of the new equation, $T(5)$, and **Manipulate** ► **Calculate**. The Theory will look like the following.

Selection before substitution $\begin{aligned} & \square y = T(x) \\ & \square x = 5 \end{aligned}$	After substitution and Calculate $\begin{aligned} & \square y = T(x) \\ & \triangle y = T(5) \quad \textit{Substitute} \\ & \triangle y = 32 \quad \textit{Calculate} \\ & \square x = 5 \end{aligned}$
--	---

The **Substitute** Palette icon is inside the pop-up hammer icon and looks like a lighting bolt (with a light grey background).



Since you have limited the domain $(-5..5)$, if you try to input a value outside the domain, *MathView* will generate a ?

You can now change the value of x to immediately obtain other y values when you have **Always ReManipulate** turned on. Try this by selecting the 5 in the $x = 5$ equation and changing it to a 2.

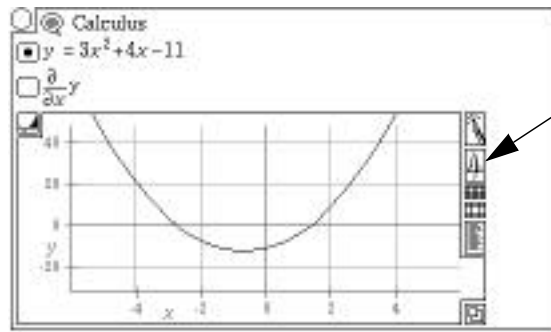
To demonstrate some calculus manipulations, create a Case Theory below everything in the Notebook.

- Select the last Prop in the notebook (it should be the last Case Theory) and press .

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To make the Comment area smaller, first change the global width of comment areas.

- Choose **Comment Rulers...** under the **Notebook ▶ Notebook Prefs** menu, change the width to 4 inches and press [return] .
- Enclose the Assumption in a Case Theory (with the Prop selected, choose **Case Theory** under the **Notebook ▶ Insert** menu). Press [enter] to turn the Assumption into a Comment, and type **Calculus**. After pressing [return] , type the equation $y = 3*x^2 \text{[esc]} + 4*x - 11$
- Generate a Linear Graph Theory and zoom out once.
- Select the Prop with the equation and press [return] to create a new Prop.
- To find the derivative of this function, click on the Derivative Op icon on the Palette. Type a y , \dagger and type an x . The Case Theory will look like the following.

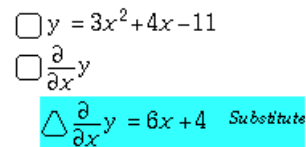
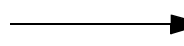
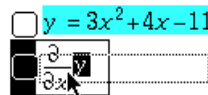


Click here once to zoom the graph out.

Recall, that to get the hand, you hold down [⌘] (Mac) or [Ctrl] (Win) as you click down on a selected expression.

- Select the y equation (click once on the equal sign), and with the Hand, drag it to the Derivative Prop. *MathView* will produce the derivative function.

Substitute with Hand Cursor



You can have the Graph Theory dynamically show the function and its derivative by adding a line plot you define as the derivative of y .



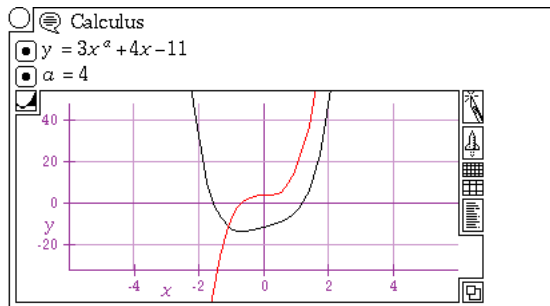
- Eliminate the derivative assumption Prop and its conclusion by selecting and pressing f .
- Select the Graph by clicking on the Graph icon in the upper left corner of the graph and choose **Graph ▶ Additional ▶ Add Line Plot**. This adds a second line detail with the same characteristics as the first, except for a new line color. Open the details and select the y in this detail.

η_x . Line at $[x, y]$ where $x = \text{left} \dots \text{right}$ with a [normal] line, colored [Red] .

You can also select the equation and choose **Add Line Plot**.

- With the y highlighted, click on the Derivative Op again and type an x . The Graph Theory is now set up to change both plots when you change the original equation.

- Select the power of x in the original equation (2) and replace it with a . Press $\boxed{\text{return}}$ and type $a = 2$. The graph will re-draw after a **Clarify** (under the **Notebook** menu). Change the value of a and watch the Graph Theory re-draw, both the function and the new derivative. The screen-shot below shows $a = 4$.



To complete this example you will find the function whose derivative is $3x^2 + 4x - 11$. In other words, you turn the equation above into a differential equation, and solve.

- Create a new Case Theory below the **Calculus** Case Theory, by clicking on the circle icon, pressing $\boxed{\text{return}}$, and choosing **Case Theory** under the **Notebook** ► **Insert** menu. Press $\boxed{\text{enter}}$, on the numeric key-pad, and type **Differential Equation**
- Input the function in differential form. You do this in the following manner. Press $\boxed{\text{return}}$, and type

$$/d*y \boxed{\text{tab}} d*x \boxed{\text{esc}} = 3*x^2 \boxed{\text{esc}} + 4 * x - 11$$



- Select the whole equation, by clicking on the equal sign, and choose **Apply** under the **Manipulate** menu. *MathView* selects both sides of the equation, at the same time, for you. Type * $d*x$ to multiply the differential to both sides. Once you have performed this step, select the whole equation again by clicking on its equal sign and choose **Manipulate** ► **Simplify**.

$\square \frac{dy}{dx} = 3x^2 + 4x - 11$	Select the equation and Apply
$\triangle \frac{dy}{dx} = 3x^2 + 4x - 11$	Take $d*x$ times each side
$\triangle \frac{dy}{dx} dx = (3x^2 + 4x - 11) dx$	Apply Simplify
$\triangle dy = (3x^2 + 4x - 11) dx$	<i>Simplify</i>

Do not use the Palette image of the integral in this example, as it will add a second differential.

- Your notebook should still have the equation selected; if not, select it now. **Apply** again, then type a \$ sign ($\boxed{\text{shift}} - 4$), which applies the Integral Op to both sides. Select the equation and **Simplify** with **Auto Casing** turned on. Choose **Auto Casing** under the **Manipulate** ► **Manipulation Prefs** menu

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prior to the simplify.

The subscripts for c may be different in your notebook. Do not worry, you will learn how to change them later in the guide.

$$\begin{aligned} \triangle \int dy &= \int (3x^2 + 4x - 11) dx && \text{Apply} \\ \triangle y + c_{100} &= x^3 + 2x^2 - 11x + c_{101} && \text{Simplify} \end{aligned}$$

- **Isolate y** and combine the constants by selecting both and typing a c without a subscript. A new Assumption generates because you have changed the Conclusion.

The screenshot shows a sequence of steps in a MathView session:

- Initial state: $\frac{dy}{dx} = 3x^2 + 4x - 11$
- Step 1: $\triangle \frac{dy}{dx} dx = (3x^2 + 4x - 11) dx$ (Action: Apply)
- Step 2: $\triangle dy = (3x^2 + 4x - 11) dx$ (Action: Simplify)
- Step 3: $\triangle \int dy = \int (3x^2 + 4x - 11) dx$ (Action: Apply)
- Step 4: $\triangle y + c_{100} = x^3 + 2x^2 - 11x + c_{101}$ (Action: Simplify)
- Step 5: $\triangle y = x^3 + 2x^2 - 11x + c_{101} - c_{100}$ (Action: Isolate)
- Final state: $\square y = x^3 + 2x^2 - 11x + c$

- Many times you will want to have a hard copy of a *MathView* session. To print this notebook, choose **Print Notebook...** under the **File** menu. Choose the print settings you want when the dialog opens and press .

This completes the first example. It does not demonstrate all of the manipulations available within *MathView*, but should give you a good start. The next section starts at the beginning and works its way through many of the basic features of *MathView*. The later chapters introduce many features through the use of examples.