The MathResource™

iNteRACTIVE mATH dICTIONARY

by MathResources

www.mathresources.com

TABLE OF CONTENTS

Introduction

Why a Mathematics Dictionary?

Mathematics is the language of science and technology. The teaching and learning of any language requires the fundamentals that a dictionary provides. *The MathResource: Interactive Math Dictionary* (*The MathResource*) is a dictionary and much more. It combines concise definitions with Maple® to provide a dynamic environment for studying, investigating and displaying mathematics. It is a powerful resource that works equally well as a study tool or as a display tool in the classroom.

The MathResource truly is an interactive dictionary. Covering a comprehensive list of topics from Pre-Calculus to Linear Algebra to Logic and more, each topic has its own guide for quick and easy access to the database. Many entries have math examples that are linked directly to the Maple® engine. They can be explored with the sample data provided or by entering values of your own.

Maple®, a powerful problem-solving and visualization system developed at the University of Waterloo, generates the example results. The Maple® engine, which is embedded in *The MathResource*, calculates and displays results from problems involving formal mathematical definitions, returning the results as mathematical objects.

The MathResource gives you flexibility and power without having to write Maple® code. *The MathResource* can be your math tutor at home, in the lab, or anywhere a PC is available.

The Math Engine

Maple® provides the mathematical calculation engine of *The MathResource*. It is a powerful mathematical problem solving and visualization system used world wide in education, research, and industry. Its principal strength is its symbolic problem solving algorithms. Unlike conventional math software, which can only work with floating-point numbers, Maple® can solve problems involving formal mathematical definitions and return answers as mathematical objects. Derived from over a decade of research and development and customer service, Maple® is a valuable tool for users in education, research, and industry.

Maple® is a registered trademark of Waterloo Maple Inc.

No matter what your field: mathematics, statistics, physics, chemistry, your math capabilities are reinforced with *The* M*athResource*

Organization and Layout

Designed for Ease of Use

The MathResource has been laid out to facilitate ease of use.

- Terms, definitions and examples each have their own frame. A list of the terms you have investigated is maintained for each session.
- Bookmarks enable you to quickly return to terms and expressions you often need.
- Examples that generate plots have their own windows.

Samples of *The MathResource's* different components are displayed in the next sections.

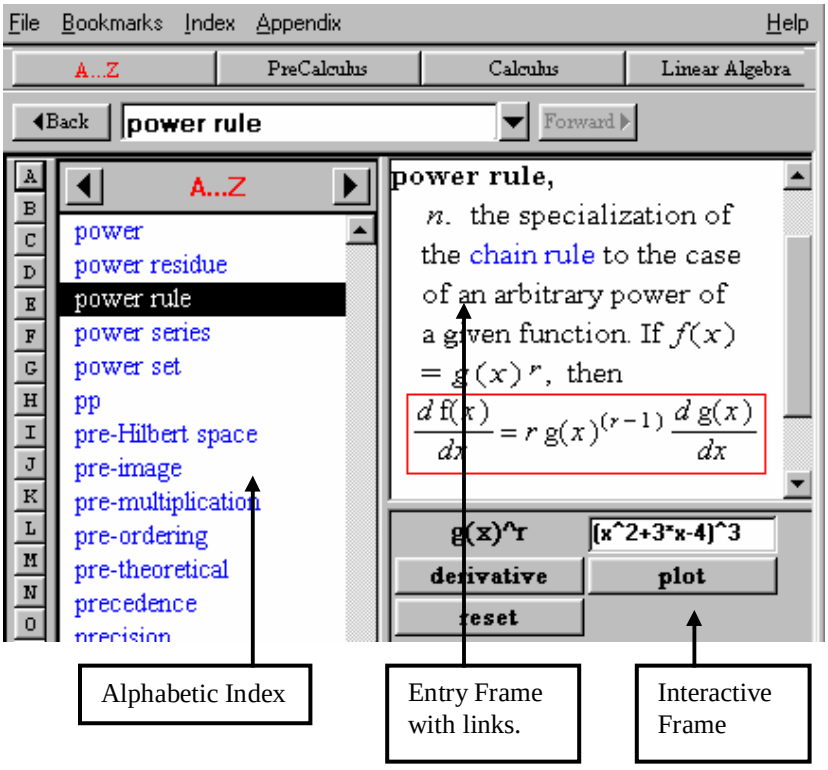
Frames

The three main frames of *The MathResource* window are:

- The **Alphabetic Index** which lists available terms.
- The **Entry Frame** which contains the definition and any example expressions. **Links** in a definition are displayed in blue and green.
- The **Interactive Frame** where expressions are evaluated, parameters entered, calculations executed and results displayed. This frame sizes itself dynamically.

All frames can be resized by clicking and dragging on their borders.

Main Window and Components of *The MathResource*



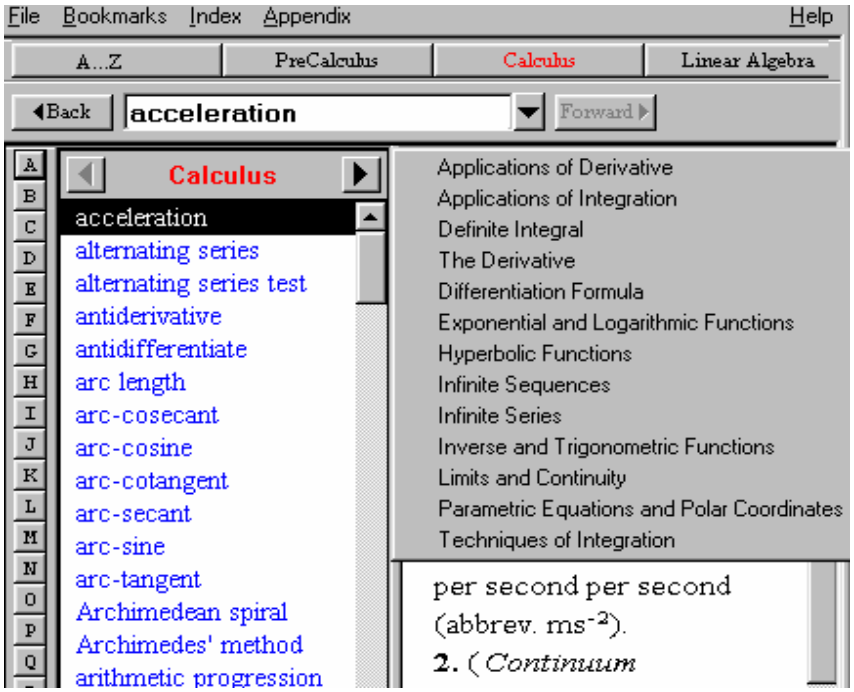
Boxes, Buttons and Links

The **Search Box** displays the current term. You can type in the search box to locate a term. A drop down list of terms looked up in the current session is opened by clicking on the down arrow symbol at the far right of the search box.

Letter Buttons, located to the left of the alphabetical index, quickly position you alphabetically.

Index Buttons, located along the top of the screen, are preset selections that filter out certain subsets of definitions, based on the button text. When one is selected it changes color and a drop down menu of topics and subtopics displays. See the Index menu for a complete list of available indices.

The screen below displays the cascading menu that appears after clicking the **Calculus** button.



Note that the heading on the list of terms has changed to "Calculus".

The **A-Z** button removes all filters and makes all terms accessible.

Text shown in **blue** is a hypertext link to a related term.

The Maple® engine can evaluate expressions shown in **green**. Clicking on them activates the Interactive Frame.

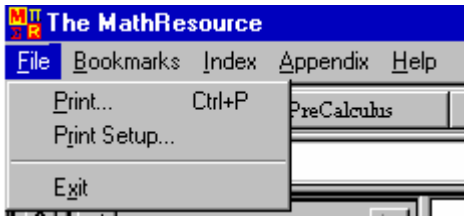
When you position the mouse pointer over either blue text or a green expression it turns into a hand pointer indicating an active link.

Menu Options

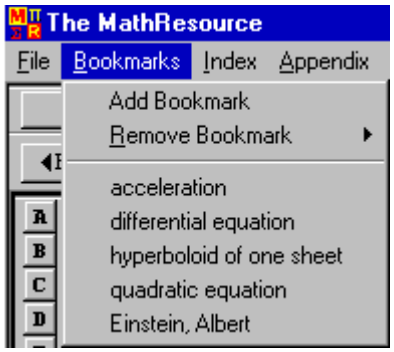
The options offered on *The MathResource's* menu follow normal Windows conventions.

The choices offered by each are:

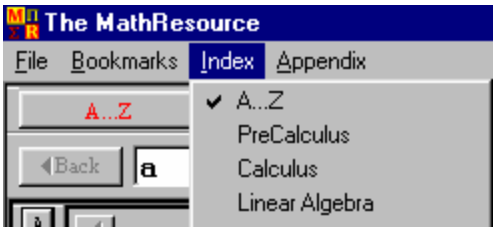
File - Printing functions and Exit.



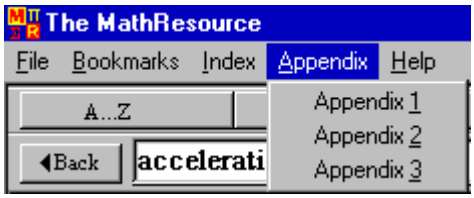
Bookmarks - Displays a list of bookmarks and options for adding and removing terms from the list.



Index - For setting views of the dictionary by subject.



Appendix - For access to the appendices.



Help - For the on-line help and to display information about The MathResource.

Output Windows

Graphical output from Maple® displays in a separate output window, which bears the name of the term evaluated. These windows exist independently of The MathResource main window

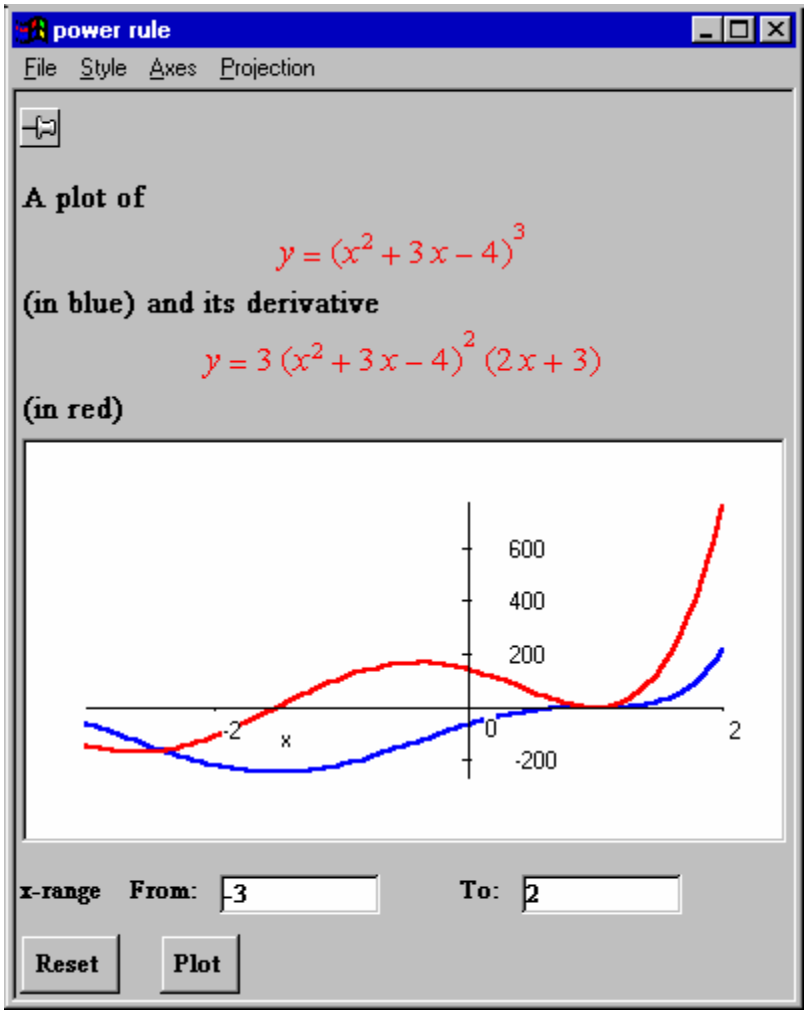
Output Windows

Graphical output from Maple® displays in a separate output window, which bears the name of the term evaluated. These windows exist independently of *The MathResource* main window and have their own menus, buttons, and text boxes for entry of variables.

The main types of output windows generated by *The MathResource* are plots, animations and numeric results.

Several output windows, each generated with different parameters, can be displayed simultaneously. This allows you to see immediately the impact that changing parameters can have on plots, animations and/or numeric results.

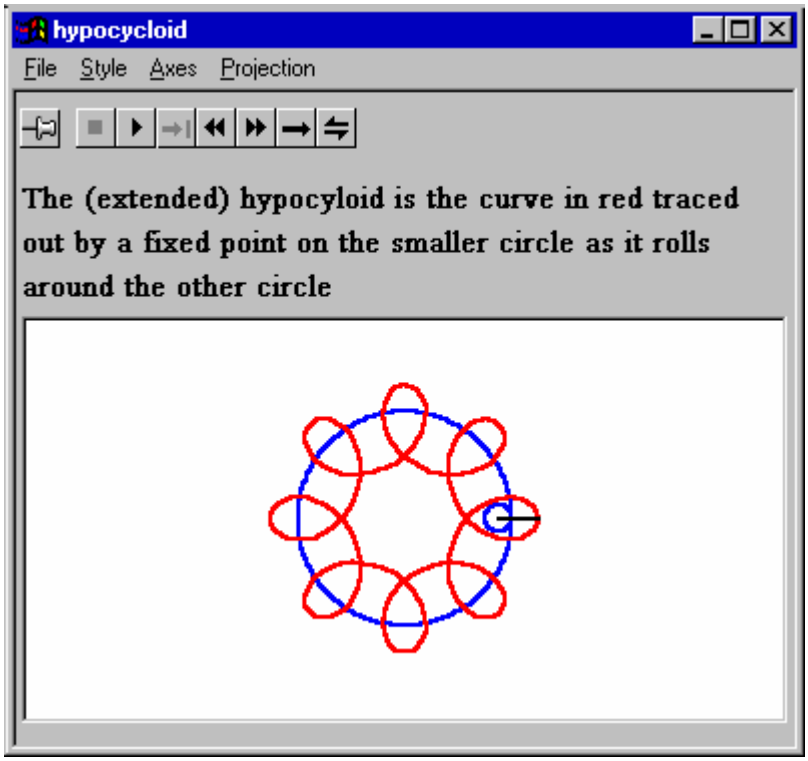
Examples of each type of output window follow.



Plots

This Output Window shows a plot using the power rule as an example. Notice that you can change the x-range and re-plot the function with these new values. If you do change the x-range and then want to see the original plot again simply click the Reset button.

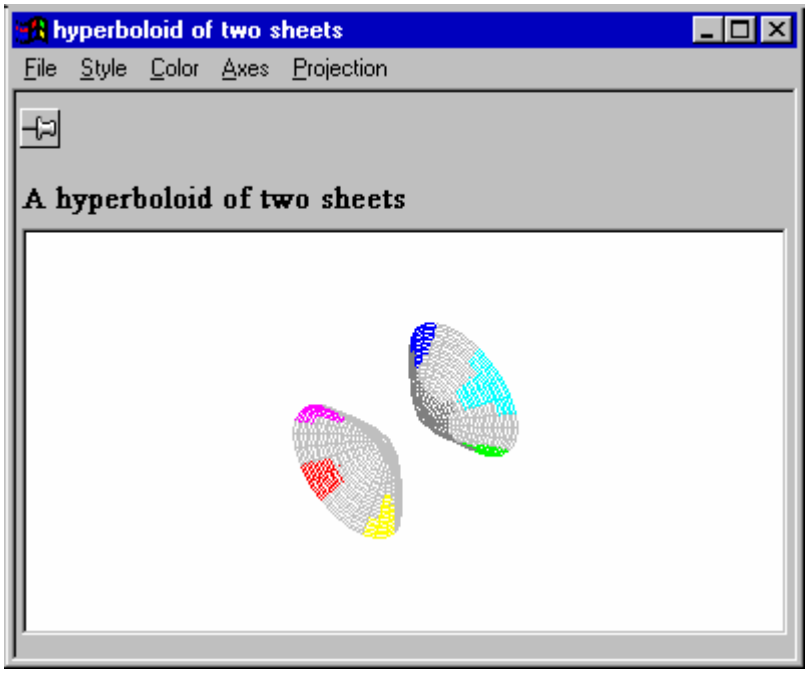
You can also use the available menus to alter the style, axes and projection of the plot. Plots can be saved and printed as well.



Animation

The Output Window of the animation of a hypocycloid is shown in this screen shot. The hypocycloid is shown after running the animation. In this example we changed the default data in the Interactive Frame. We entered a large radius of 8 and a small radius of 1. The extension remained the same at 1.

Again, if you make changes and then want to see the default data simply click the Reset button in the Interactive Frame.



3-D

The Output Window of a three-dimensional plot, the Hyperboloid of Two Sheets, is shown in this screen shot. The plot of the Hyperboloid of Two Sheets is in a fully functioning Maple® window and you can now do anything to your plot that Maple® can do. Alter the style, color, axes or projection of the plot by using the available menus. Try playing around with the different options just to see how they affect the appearance of the plot.

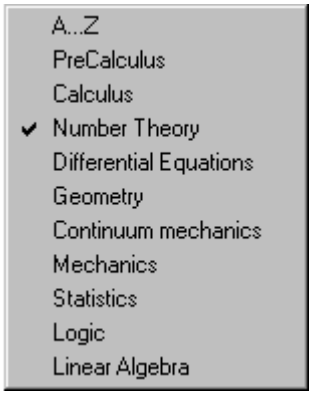
You can also rotate this plot by clicking on the left mouse key. When you have rotated it to the new position you want, click the right mouse key to see the plot again. This is a great way to view all the aspects of a 3-D plot.

Using *The MathResource*

Moving Around

The MathResource enables you to quickly find dictionary entries and to move back and forth among related terms. This helps to broaden the meaning of terms, expanding your understanding. The evaluation of expressions, the plots and the animations lets you try out different values and see the results of your changes right away.

From the Alphabetic List, or within a definition, hypertext links connect you to related terms. In addition you can choose alternate views of the dictionary by subject index, you can search for a specific entry, or you can set and use your own bookmarks. A temporary bookmark list of terms you have looked at in the current session is automatically maintained for you, making it easier to move back and forth.



The list to the left is the complete **Index** of the subjects found in *The MathResource*. Right click to pop up an index list. A check mark indicates your selection.

Links

The MathResource has been designed to facilitate movement, especially connected movement, by hypertext links within the database. There are two types of links - text links, which display in **blue**, and expression links, which display in **green**.

You can also move around in dictionary order and return to previous lookups.

To Use a Hypertext Link - Text or Expression

1. Position the mouse pointer over the colored text (**blue**) or expression (**green**). If the link is active it will change shape to a pointing hand.
2. Click on the text or expression. If it is a text link that term will be looked up in the dictionary and displayed in the Entry frame. If it is an expression the Interactive Frame will open below the Entry Frame and you can explore the expression.

To Move to Next or Previous Entry - Dictionary Order

1. Click on the arrow button located on either side of the Alphabetic Index header. The arrow pointing to the left moves up one term, the arrow pointing to the right moves down one term.
2. Repeat as desired.

To Return to Previous Lookups

The MathResource maintains a list of entries looked up in the current session. There are two ways to move through this list -- move a term at a time or pick from the list of visited entries.

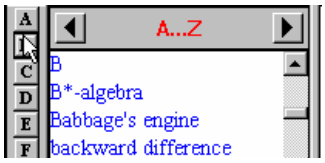
- Click on the buttons on either side of the Search Box, which are labeled "Forward" or "Back". This will move up and down the list of entries looked up in the current session.
- Click on the down arrow to the right of the Search Box and pick a term from the drop down list, which appears.

Scrolling & Entry Searching

The letter buttons and the scroll bar enable you to move quickly through the list in alphabetical order. Key word searches locate specific terms.

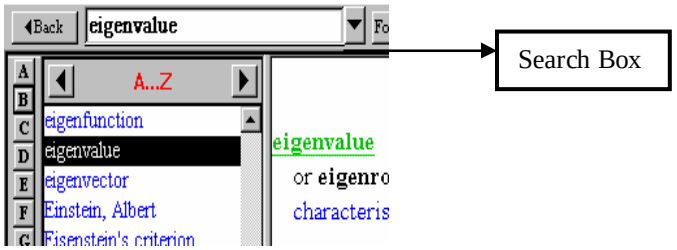
To Use the Alphabetical Index

- By Letter Button - Click on a letter button to the left of the alphabetical index. You will be positioned on the first term, which starts with the letter you selected. Clicking on the left arrow and right arrows symbols located on either side of the Alphabetical Index's header moves you through the list term by term.
- By Scrolling - Drag the scroll bar to the right of the alphabetical index upward and downward to move through the list of terms.



To Search by Key Word

1. Click on the Search Box. This ensures that what you type will be placed in the box.
2. Type the term you are searching for, or its first few letters.
3. Press **Enter**. *The MathResource* will find the term or its closest match, and display the definition.



The MathResource maintains a list of terms looked up in the current session. Activate it by clicking on the down arrow to the right of the Search Box.

Clicking on the Forward and Back buttons to the left and right of the Search Box moves you through this list of terms.

Setting a View of the Dictionary

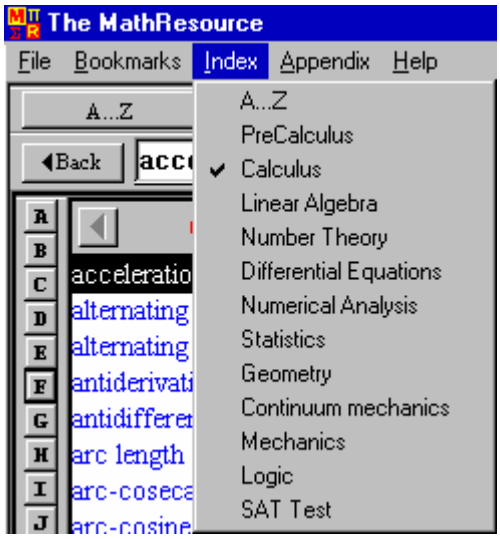
You can focus *The MathResource's* dictionary into several different subsets to make it a more effective study and research tool. By selecting an index and focusing on the area you are working in you can escape "dictionary-itis"; the delightful happenstance where an unknown term unrelated to what you are working with catches your eye sending you off and wandering amongst the hyperlinks. This may still occur but you will be browsing amongst a selected subset of the dictionary.

To Select an Index

- Click on the Index Button labeled with the desired view. Not all of the available indices have buttons. For a complete list of all the indices available take a look at the Index menu.

The header of the Alphabetic Index changes to reflect the view and the label on the button changes to red.

- Click on the Index button on the menu and select from the list.



To Reset the Default View

- Click on the Index button labeled "A....Z".

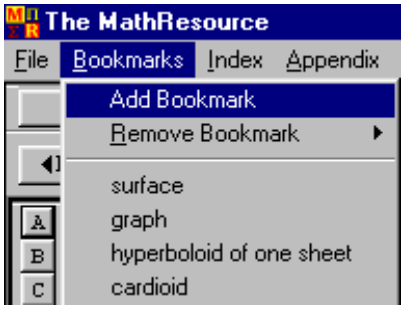
All entries in *The MathResource's* dictionary are displayed in the Alphabetic Index. When it is activated the header changes to "A...Z", and the "A...Z" button label displays in red.

Setting, Clearing and Using Bookmarks

The MathResource's bookmarking capability gives you, in essence, your own mini-dictionary of those terms you refer to frequently. Setting, clearing and removing these bookmarks is under your complete control.

To Set a Bookmark

1. Have the term you want to add visible in the Entry frame.
2. Click on the Bookmarks button in the menu. The Bookmarks menu drops down.
3. Click on Add Bookmark. The term is added to the bookmark list.



To Clear a Bookmark

1. Click on the Bookmarks button in the menu. The Bookmarks menu drops down.
2. Click on Remove Bookmark. The list of current bookmarks pops up.
3. Click on the term you want to remove. The list of bookmarked terms disappears and the term is removed from the list of bookmarks.

To Use a Bookmark

1. Click on the Bookmarks button in the menu. The Bookmarks menu and list of current bookmarks drops down.
2. Click on the term you want. The Bookmarks menu disappears and the term is displayed in the Entry frame.

Exploring Expressions

When an expression, formula or specific word is displayed in green or has a green box around it, clicking on it opens the Interactive Frame. Text Boxes within that frame allow you to enter values for variables contained in the expression.

When entering parameters you must follow the Three Golden Rules. As the Maple® engine will try to evaluate whatever is entered, infinite loops **are** possible.

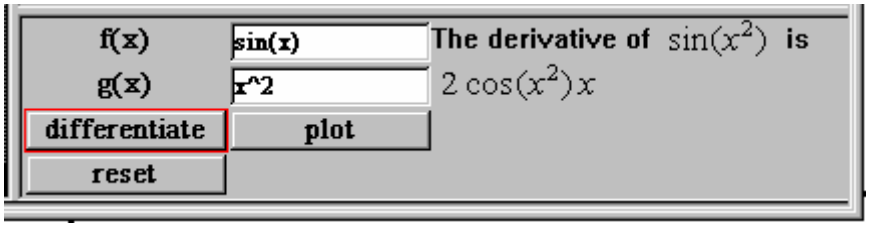
Buttons in the Interactive Frame trigger an evaluation or plot of the expression. They are set dynamically and vary according to the expression.

Clicking on a Plot or Animate button, if present, causes *The MathResource* to open an output window with a plot or animation of the expression.

Input – The Three Golden Rules

Adhere to these rules when entering parameters in the text boxes provided for expression variables.

1. Multiplication — *ab* must be expressed as ***a*b***. The operator is required.
2. Exponentiation, simple — x^2 must be expressed as ***x*^2***. The "^", or caret is the symbol found above the numeral 6 on the keyboard.
3. Exponentiation, using an expression — x^{n+1} must be expressed as ***x^(n+1)***.



Rule 2 - Note how g(x) - x^2-is displayed by Maple® as x^2.

Input - Legal Expressions

A reminder—the Maple® engine will try to evaluate any legal expression, but keep the syntax correct and keep the required variables.

Remember Maple® processes in the background so if the expression you input is too demanding your computer's resources may be exhausted. Your machine may appear to be non-responsive and a crash could result.

Tip –

K Use the **Surface** entry for a 3-D plot of any *x* and *y*.
K Click on the word drawing in the **Graph** entry to plot any function of *x*.

Plots, Animations and 3-D Renderings

If the expression in the Interactive Frame can be displayed as a plot or animation, **Plot** or **Animate** buttons will be displayed. Clicking on them triggers Maple® to evaluate the expression and then brings up an output window containing the plot or animation.

You can alter the properties of the output window, so formatting the output is under your control. The following steps apply equally to both plots and animations. **Note**: The term plot has been used for convenience.

To Display a Plot

1. Click on the **Plot** button in the Interactive Frame. The Maple® engine calculates and displays the results in a separate output window that bears the name of the term.
2. Repeat as desired, adjusting input parameters if you wish.

Note that a new output window is generated for each successive plot. Output windows stack one atop the other.

Tip –
K Set the pushpin to keep the output window on top.

The axes may hide parts of the plot as Maple® draws them last. Turn the display of the axes off or change the style of the axes if this is a problem. See **Output Window - Menu Options** on page 25 for more information about the Axes menu.

To Change the Values in a Plot Window

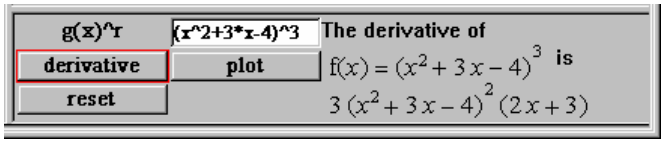
- Enter your new values in the text boxes.

In the example below, taken from the Power Rule output window, the highlighted box on the right has been clicked on. A new value can now be entered. Typing in this box will replace the highlighted value.

Example—Text Boxes in an Output Window.

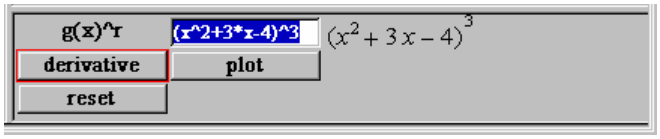
To Change the Function for a Plot

1. Click on the Interactive Frame and look at the term.



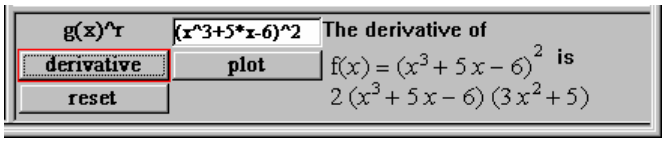
Interactive Frame for Power Rule before changing expression.

2. Double click on the expression displayed in the Interactive Frame that you want to change. It will become highlighted within its text box. The box will automatically resize itself to display the expression. It snaps back to its normal size once you tab away from it or click elsewhere.



Expression has been highlighted and pretty-print is shown

3. Type in your new expression or variables, keeping syntax legal and having the required variables.



Expression has been changed and Derivative is shown

These same steps apply to changing input variables as well.

To Run an Animation

Click on the **Animate** button. Maple® develops a series of bitmaps, which display as you run the animation. When the output window appears the animation is at its starting point. Control the display by clicking on the Animation buttons at the top of the display.

The animation buttons as they are displayed in the output window.

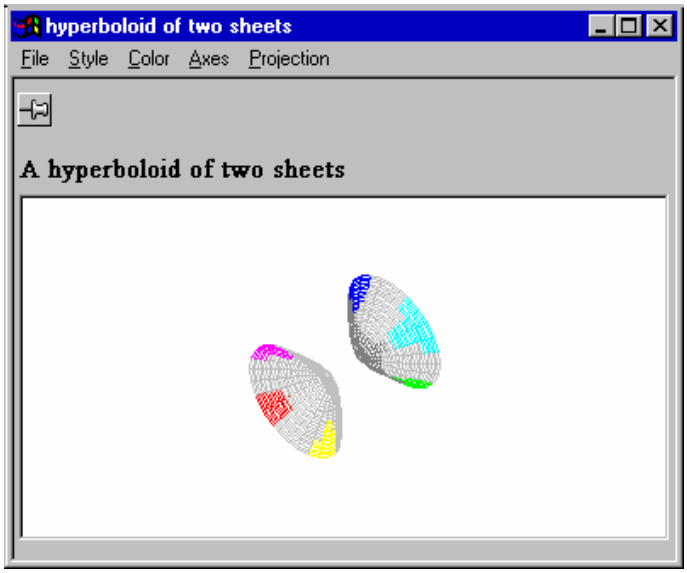
Button	Description
	Stop Button - Click to Stop a running animation.
	Run Button - Click to start animation.
	Single Step Button - Click to step through animation.
	Decelerate Button - Click to slow down.
	Accelerate Button - Click to speed up.
 and 	Direction Button - Click to change direction of animation. Button face changes to show current direction.
 and 	Cycle Button - Click to run animation once or continuously. Button face changes when clicked.

To Rotate a 3-D Rendering

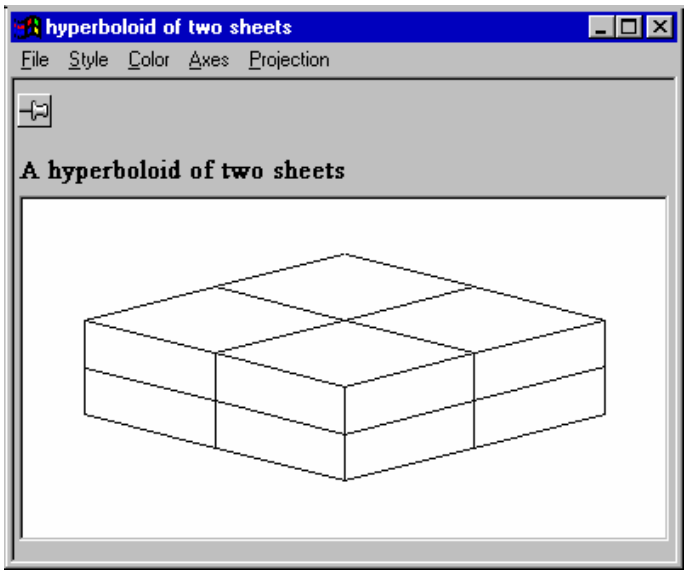
Clicking on the **Plot** button causes Maple® to generate an initial rendering and display it in a default position in the output window. To rotate the rendering and to change its position follows these steps.

1. Left click in the display area of the output window. The rendering disappears and becomes a box.
2. Change the orientation of the box by clicking on it and dragging - left, right, up, down, invert - whatever you want.
3. Right click in the display area. A new rendering is generated and displayed.

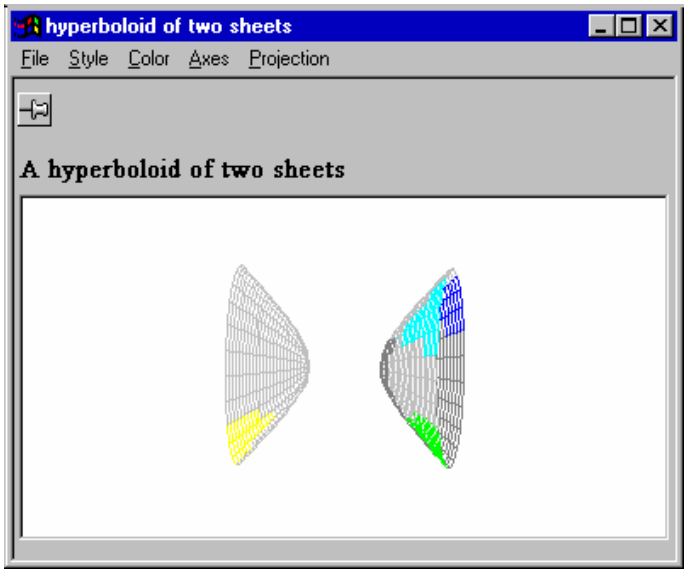
The following series of clips show the display at each of these stages.



1. Initial Display - Default Position



2. Display of Box - Ready to Rotate



3. Final Display - After Rotation

Creating Your Own 3-D and 2-D Plots

The MathResource offers you a lot of built-in examples and functions, but you may want to investigate your own. You can do this by entering your own general mathematical functions. Do it this way.

For a **3-D** expression go to "**surface**" and in the Entry Frame click on **z=f(*x*,*y*)** to open the Interactive Frame.

Highlight the expression displayed and type your own expression in the text box. You must have **two variables** and they must be ***x*** and ***y***. Click on **plot** to display your function.

Two sample expressions you may want to try are

x^2 + *y*^2 and sin(*x***y*)

For a **2-D** expression use "**graph**" and in the Entry Frame click on **drawing** to open the interactive frame. Follow the same process with one change. You must have **one variable** and it must be ***x***.

Two samples you can try are

sin(*x*) and *x**sin(*x*).

Why the insistence on *x* and *y*? The Maple® engine will accept only those variables; using others, like *a* or *b* will generate an error message.

Output Window - Menu Options

The Output Window menus provide essentially the same options for plots, 3-D renderings and animations, although the number of choices for each will vary according to the expression. Try each out and experiment until you achieve the effect you want.

The general menu options are

- **File** - To save the output windows as a bitmap or to print it.
- **Style** - To control the display options - line thickness, line style, *etc*.
- **Color** - To alter the colors of the plot. The color menu is only available in the 3-D output windows.
- **Axes** - To control the display of information about the axes. For example, in a 3-D output window, "boxed" displays the axes along the edges of a box containing the rendering; "normal" punches the axes out from the center of the rendering. If the axes interfere with your graph, select None to remove them.
- **Projection** - To control perspective and whether or not the display is constrained. Some functions display better when constrained, others are clearer without constraints. Plot and compare a hyperboloid of two sheets and the power rule with and without constraints.

Some Examples - Step by Step

Putting It All Together

Everything shown so far has been focused on how to do a particular action. In this section we will go through the process of looking up a term, amending it and then displaying it step by step.

The first example will be a plot. The emphasis here is on sequence. We will explore the sequence, referring to the sections that contain information on what we want to do.

The same sequence is followed for 3-D renderings and animations, but their display options are a little different.

Working Up a Plot

Your assignment asks you to define the term "power rule" and to illustrate your definition. *The MathResource* makes it easy.

Look up the Definition

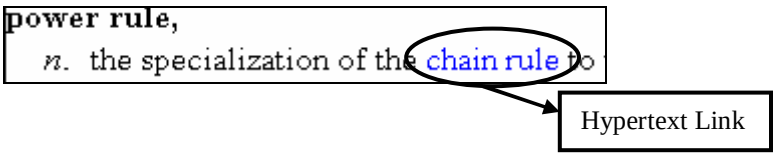
You can do this by scrolling through the alphabetic list or by selecting the **Calculus Button** and picking the term from the list under Differentiation Formula. We suggest you use the Search Box as described in To Search by Key Word on page 10.

Search Box

Type "power rule" in the Search Box and press **Enter**. *The MathResource* searches its index, locates the term and displays it in the Entry Frame.

Read the Definition

Read the displayed definition. If terms you do not understand are used, follow their highlighted links as described in To Use a Hypertext Link - Text or Expression on page 9.



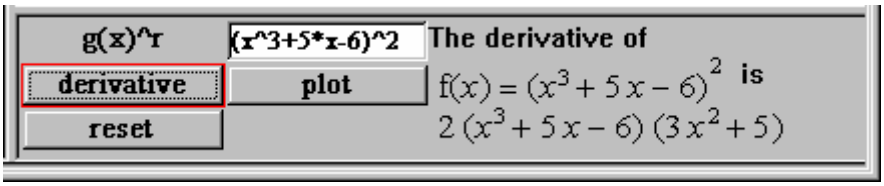
Sometimes you can wander pretty far using the hypertext links, but getting back to the power rule definition is easy. Instructions on how to do that are found in To Return to Previous Lookups on page 9.

Check Out the Math

Words are fine, but this is a *math* dictionary. Move the mouse pointer over the expression with the green box around it. When it changes to a hand, click on it to open the Interactive Frame below.

Once the Interactive Frame is open you can enter a new expression, or change variables. There is a whole section on this, entitled Exploring Expressions which starts on page 12. Pay particular attention to

- Input – The Three Golden Rules
- Input - Legal Expressions



Click on the **derivative** button and Maple® evaluates your expression and displays the result in "pretty print" format in the Interactive Frame.

Click on the **plot** button and Maple® again evaluates the expression and prepares a graph. *The MathResource* then opens an Output Window and displays it.

To return to the original expression click on **reset**.

Experiment with the Plot

The MathResource's Output Window is interactive as well. The section on Plots, Animations and 3-D Renderings starting on page 19 describes what is possible.

Text boxes let you enter new values and clicking on the **Plot** button regenerates the graph. Check out To Change the Values in a Plot Window and To Change the Function for a Plot starting on page 13.

The appearance of the display can be changed using the Style, Axes and Projection options on the menu. What's on offer is described in Output Window – Menu Options on page 25. It really is best to play with the options to see the effects they can make on both the 2-D and 3-D plots.

Exploit *The MathResource*

Now that you have spent some time on this assignment, you can turn it to practical use.

Save the graph you have developed. Choose **File/Save** from the Output Window menu, name the file and insert it into your document.

More importantly - relate your understanding of the term and how it is used in your context, demonstrating what you have learned.

Do It in 3-D

For 3-D renderings you alter expressions and values as you do for plots. The output is different - you can rotate it in three dimensions.

A good term to experiment with is a "hyperboloid of two sheets". If you want to make changes follow the steps in Working Up a Plot on page 26.

Once the graph has been plotted, change your view of it. Check the steps in To Rotate a 3-D Rendering on page 14.

Animate, Animate, Animate

Animations are fun - you can run them forwards, backwards, step by step, only once or continuously, or quickly or slowly.

Start with a "hypocycloid", clicking on the green colored text "extended hypocycloid" to open up the Interactive Frame. Animate it. All the preliminaries of looking up the term and exploring the math are covered in Working Up a Plot beginning on page 26.

Now the fun begins - this is almost like a Spirograph for adults! Run it, following the steps in To Run an Animation on page 21.

Trouble Shooting, Installation & Who to Call

No Output from Maple®

The most common cause of Maple® failing to generate output is the incorrect entry of parameters. Check Input – The Three Golden Rules on page 18 if you need to refresh your memory.

Also be aware that Maple® will attempt to evaluate any legal expression. You may have assigned it a big problem. See Input - Legal Expressions on page 19.

The axes may hide parts of your plot. See To Display a Plot also on page 19.

Windows 3.11 users, if you encounter difficulties generating plots, increase colors to 256.

No Result from Hyperlink

The selected term, although displayed in color, may not be mapped.

Please contact MathResources Inc. by
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Installing & Removing

Installation is simple, and we hope you will find *The MathResource* a useful and helpful utility. However, if you no longer need it on your system we show you what to remove.

Downloading & Installing from MathResources' Website – If you purchased The MathResource on-line, then you would have been emailed a serial number and asked to download the installer file from the webpage below.

http://www.mathresources.com/downloads/mr_win.html

Follow the directions on that page.

Installing from CD-ROM - If you purchased the MathResources as a CD-ROM you DO NOT NEED A SERIAL NUMBER TO USE THE SOFTWARE. Just make sure your CD-ROM is in your D: drive. If this is different, substitute the drive letter used on your system.

1. Insert *The MathResource* CD-ROM in the drive.
2. In the Program Manager Window click on **File**. The File Menu drops down.
3. Click on **Run**. The Run dialog appears with a box entitled "Command Line".
4. Type D:\SETUP in the box and click on **OK**. The installation program will start. Follow the prompts and instructions.

Windows95 users - Click on the "Add/Remove Programs" icon found in the Control Panel and follow the instruction.

To Remove

If your computer has Windows95 installed click on the "Uninstall" icon and the installation program will remove *The MathResource*. To manually remove *The MathResource* follow the steps below.

You can Use "Add/Remove Programs" here too.

1. Click on the File Manager icon and start Windows File Manager.
2. Highlight the subdirectory where *The MathResource* is located. Unless you have changed its name during installation it will be MathReso.
3. Press the **Del** key. Depending on how you have configured your system dialogs may appear asking for confirmation on deletion of the subdirectory and all its contents.
4. Click on **OK** or **Yes**. This subdirectory, the program and the dictionary index files will be removed.
5. Close File Manager
6. In Program Manager highlight *The MathResource* program group.
7. Press the **Del** key to remove it.

This procedure will remove all traces of *The MathResource* from your system. If you have copied the icon to other program groups you will have to highlight it and delete it from those groups.

Contacting MathResources Inc.

You can reach MathResources Inc. in the following ways:

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We would love to hear your comments and suggestions.

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