Chapter 2
Getting Started with Mathcad

This chapter provides a quick introduction to computing with Mathcad and demonstrates a few more advanced features like iterative calculation and two-dimensional plotting. After you read this chapter, you'll have enough information to begin to solve your own problems in Mathcad.

The following sections make up this chapter:

The Mathcad workspace

Overview of menus and toolbars.

Regions

How equations, text, and graphics make up a worksheet; the mechanics of selecting, copying, moving, and deleting regions.

A simple calculation

Calculating with Mathcad.

Definitions and variables

Creating simple Mathcad equations.

Entering text

Adding notes and labels to a worksheet.

Iterative calculations

Using range variables to repeat an equation for several values.

Graphs

Building a simple two-dimensional plot.

Saving, printing, and exiting

The Save, Print, and Exit commands from the File menu.

For information on system requirements and how to install Mathcad on your computer, see the instructions that accompanied your installation media.

When you start Mathcad, you'll see a window like that shown in Figure 2-1. By default the worksheet area is white. To select a different color, choose **Color⇒Background** from the **Format** menu.

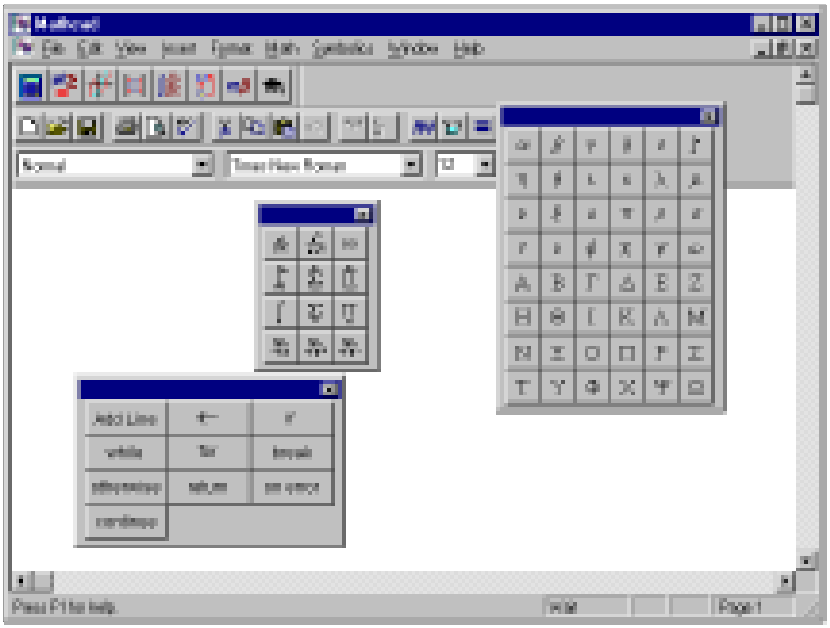


Figure 2-1: Mathcad Professional with math and other toolbars displayed.

Each button in the **Math toolbar**, shown on the left side of the Mathcad window in Figure 2-1, opens another toolbar of operators or symbols. You can insert many operators, Greek letters, and plots by clicking the buttons found on these toolbars:

Button	Opens math toolbar...
	**Arithmetic**—Common arithmetic operators.
	**Evaluation**—Equal signs for evaluation and definition, Boolean expressions.
	**Graph**—Various two- and three-dimensional plot types.
	**Matrix**—Matrix and vector operators.

Calculus—Derivatives, integrals, limits, and iterated sums and products.

Programming—Programming constructs (*Mathcad Professional only*).

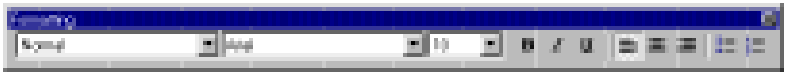
Greek—Greek letters.

Symbolic—Symbolic keywords.

The **Standard toolbar** is the strip of buttons shown just below the main menus in Figure 2-1:

Many menu commands can be accessed more quickly by clicking a button on the Standard toolbar.

The **Formatting toolbar** is shown immediately below the Standard toolbar in Figure 2-1. This contains scrolling lists and buttons used to specify font characteristics in equations and text.



Tip To learn what a button on any toolbar does, let the mouse pointer rest on the button momentarily. You'll see a tooltip beside the pointer giving a brief description.

To conserve screen space, you can show or hide each toolbar individually by choosing the appropriate command from the **View** menu. You can also detach and drag a toolbar around your window. To do so, place the mouse pointer anywhere other than on a button or a text box. Then press and hold down the mouse button and drag. You'll find that the Standard and Math toolbars rearrange themselves appropriately depending on where you drag them. The other toolbars, on the other hand, retain their shape no matter where you drag them. And Mathcad remembers where you left your toolbars the next time you open the application.

Tip The Standard and Formatting toolbars are customizable. To add and remove buttons from one of these toolbars, click with the right mouse button on the toolbar and choose **Customize** from the pop-up menu to bring up the Customize Toolbar dialog box.

Working with windows

When you start Mathcad, you open up a window on a Mathcad *worksheet*. You can have as many worksheets open as your available system resources allow. This allows you to work on several worksheets at once by simply clicking the mouse in whichever document window you want to work in.

There are times when a Mathcad worksheet cannot be displayed in its entirety because the window is too small. To bring unseen portions of a worksheet into view, you can:

- Make the window larger as you do in other Windows applications.
- Choose **Zoom** from the **View** menu and choose a number smaller than 100%.

You can also use the scroll bars, mouse, and keystrokes to move around the Mathcad window, as you can in your other Windows applications. When you move the mouse pointer and click the mouse button, for example, the cursor jumps from wherever it was to wherever you clicked.

Tip Mathcad supports the Microsoft IntelliMouse and compatible pointing devices. Turning the wheel scrolls the window one line vertically for each click of the wheel. When you press [**Shift**] and turn the wheel, the window scrolls horizontally.

See "Arrow and movement keys" on page 351 in the Appendices for keystrokes to move the cursor in the worksheet. If you are working with a longer worksheet, choose **Go to Page** from the **Edit** menu and enter the page number you want to go to in the dialog box. When you click "OK," Mathcad places the top of the page you specify at the top of the window.

Tip Mathcad supports standard Windows keystrokes for operations such as file opening ([**Ctrl**]**O**]) saving ([**Ctrl**]**S**]), printing ([**Ctrl**]**P**), copying([**Ctrl**]**C**]), and pasting ([**Ctrl**]**V**]). Choose **Preferences** from the **View** menu and check "Use standard Windows shortcut keys" on the General tab to enable all Windows shortcuts. Remove the check to use shortcut keys supported in Mathcad 7.

Regions

Mathcad lets you enter equations and text anywhere in the worksheet. Each equation, piece of text, or other element is a *region*. Mathcad creates an invisible rectangle to hold each region. A Mathcad worksheet is a collection of such regions. To start a new region in Mathcad:

- Click anywhere in a blank area of the worksheet. You see a small crosshair. Anything you type appears at the crosshair.

- If the region you want to create is a math region, just start typing anywhere you put the crosshair. By default Mathcad understands what you type as mathematics. See "A simple calculation" on page 21 for an example.
- To create a text region, first choose **Text Region** from the **Insert** menu and then start typing. See "Entering text" on page 24 for an example.

In addition to equations and text, Mathcad supports a variety of plot regions. See "Graphs" on page 27 for an example of inserting a two-dimensional plot.

Tip Mathcad displays a box around any region you are currently working in. When you click outside the region, the surrounding box disappears.

Selecting regions

To select a single region, simply click it. Mathcad shows a rectangle around the region.

To select multiple regions:

- Press and hold down the left mouse button to anchor one corner of the selection rectangle.
- Without letting go of the mouse button, move the mouse to enclose everything you want to select inside the selection rectangle.
- Release the mouse button. Mathcad shows dashed rectangles around regions you have selected.

Tip You can also select multiple regions anywhere in the worksheet by holding down the [**Ctrl**] key while clicking. If you click one region and [**Shift**]-click another, you select both regions and all regions in between.

Moving and copying regions

Once the regions are selected, you can move or copy them.

Moving regions

You can move regions by dragging with the mouse or by using **Cut** and **Paste**.

To drag regions with the mouse:

- Select the regions as described in the previous section.

- Place the pointer on the border of any selected region. The pointer turns into a small hand.
- Press and hold down the mouse button.
- Without letting go of the button, move the mouse. The rectangular outlines of the selected regions following the mouse pointer.

At this point, you can either drag the selected regions to another spot in the worksheet, or you can drag them to another worksheet. To move the selected regions into another worksheet, press and hold down the mouse button, drag the rectangular outlines into the destination worksheet, and release the mouse button.

To move the selected regions by using **Cut** and **Paste**:

- Select the regions as described in the previous section.
- Choose **Cut** from the **Edit** menu, or click  on the Standard toolbar. This deletes the selected regions and puts them on the Clipboard.
- Click the mouse wherever you want the regions moved to. Make sure you've clicked in an empty space. You can click either someplace else in your worksheet or in a different worksheet altogether. Make sure the cursor looks like a crosshair.
- Choose **Paste** from the **Edit** menu, or click  on the Standard toolbar.

Copying regions

You copy regions by using the **Copy** and **Paste** commands:

- Select the regions as described in "Selecting regions" on page 19.
- Choose **Copy** from the **Edit** menu, or click  on the Standard toolbar. This copies the selected regions to the Clipboard.
- Click the mouse wherever you want to place a copy of the regions. You can click either someplace else in your worksheet or in a different worksheet altogether. Make sure you've clicked in an empty space. You should see the crosshair.
- Choose **Paste** from the **Edit** menu, or click  on the Standard toolbar.

Tip If the regions you want to copy are coming from a locked area (see "Safeguarding an area of the worksheet" on page 109) or an Electronic Book, you can copy them simply by dragging them with the mouse into your worksheet.

Deleting regions

To delete one or more regions:

- Select the regions as described in “Selecting regions” on page 19.

- Choose **Cut** from the **Edit** menu, or click  on the Standard toolbar.

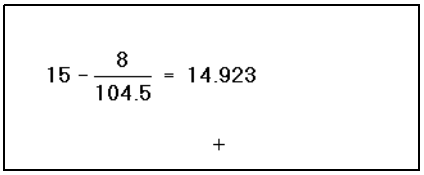
Choosing **Cut** removes the selected regions from your worksheet and puts them on the Clipboard. If you don’t want to disturb the contents of your Clipboard, or if you don’t want to save the selected regions, choose **Delete** from the **Edit** menu instead.

A simple calculation

Although Mathcad can perform sophisticated mathematics, you can just as easily use it as a simple calculator. To try your first calculation, follow these steps:

- Click anywhere in the worksheet. You see a small crosshair. Anything you type appears at the crosshair.

- Type **15-8/104.5=** . When you type the equal sign or click  on the Evaluation toolbar, Mathcad computes and shows the result.



This calculation demonstrates the way Mathcad works:

- Mathcad shows equations as you might see them in a book or on a blackboard, expanded fully in two dimensions. Mathcad sizes fraction bars, brackets, and other symbols to display equations the same way you would write them on paper.

- Mathcad understands which operation to perform first. In this example, Mathcad knew to perform the division before the subtraction and displayed the equation accordingly.

- As soon as you type the equal sign or click  on the Evaluation toolbar, Mathcad returns the result. Unless you specify otherwise, Mathcad processes each equation as you enter it. See the section “Controlling calculation” in Chapter 8 to learn how to change this.

- As you type each operator (in this case, – and **/**), Mathcad shows a small rectangle called a *placeholder*. Placeholders hold spaces open for numbers or expressions not yet typed. As soon as you type a number, it replaces the placeholder in the equation. The placeholder that appears at the end of the equation is used for unit conversions. Its use is discussed in “Displaying units of results” on page 138.

Once an equation is on the screen, you can edit it by clicking in the appropriate spot and typing new letters, digits, or operators. You can type many operators and Greek letters by clicking in the Math toolbars introduced in "The Mathcad workspace" on page 16. Chapter 4, "Working with Math," explains in detail how to edit Mathcad equations.

Definitions and variables

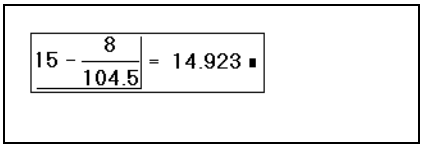
Mathcad's power and versatility quickly become apparent once you begin to use *variables* and *functions*. By defining variables and functions, you can link equations together and use intermediate results in further calculations.

The following examples show how to define and use several variables.

Defining variables

To clear the previous equation and define a variable *t*, follow these steps:

- Click in the equation you just typed and press [**Space**] until the entire expression is held between the two editing lines. Then choose **Cut** from the **Edit** menu or click  on the Standard toolbar.



- Now begin defining *t*. Type **t** followed by a colon **:** or click  on the Arithmetic toolbar. Mathcad shows the colon as the definition symbol **:=**.

- Now begin defining *t*. Type **t** followed by a colon **:** or click  on the Arithmetic toolbar. Mathcad shows the colon as the definition symbol **:=**. Type **10** in the empty placeholder to complete the definition for *t*.

If you make a mistake, click on the equation and press [**Space**] until the entire expression is between the two editing lines, just as you did earlier. Then delete it by choosing **Cut** from the **Edit** menu. See Chapter 4, "Working with Math," for other ways to correct or edit an expression.

These steps show the form for typing any definition:

- Type the variable name to be defined.

- Type the colon key **:** or click := on the Arithmetic toolbar to insert the definition symbol. The examples that follow encourage you to use the colon key, since that is usually faster.
- Type the value to be assigned to the variable. The value can be a single number, as in the example shown here, or a more complicated combination of numbers and previously defined variables.

Mathcad worksheets read from top to bottom and left to right. Once you have defined a variable like *t*, you can compute with it anywhere *below and to the right* of the equation that defines it.

Now enter another definition.

- Press [↵]. This moves the crosshair below the first equation.
- To define *acc* as –9.8, type: **acc:–9.8**. Then press [↵] again. Mathcad shows the crosshair cursor below the last equation you entered.

Calculating results

Now that the variables *acc* and *t* are defined, you can use them in other expressions.

- Click the mouse a few lines below the two definitions.
- Type **acc/2**[**Space**]***t^2**. The caret symbol (**^**) represents raising to a power, the asterisk (*****) is multiplication, and the slash (**/**) represents division.
- Press the equal sign (=).

This equation calculates the distance traveled by a falling body in time *t* with acceleration *acc*. When you enter the equation and press the equal sign (=), or click = on the Evaluation toolbar, Mathcad returns the result.

Mathcad updates results as soon as you make changes. For example, if you click on the 10 on your screen and change it to some other number, Mathcad changes the result as soon as you press [↵] or click outside of the equation.

Entering text

Mathcad handles text as easily as it does equations, so you can make notes about the calculations you are doing.

Here's how to enter some text:

- Click in the blank space to the right of the equations you entered. You'll see a small crosshair.

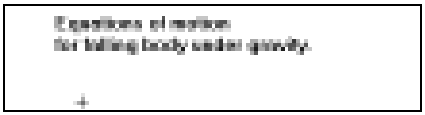
- Choose **Text Region** form the **Insert** menu, or press **"** (the double-quote key), to tell Mathcad that you're about to enter some text. Mathcad changes the crosshair into a vertical line called the insertion point. Characters you type appear behind this line. A box surrounds the insertion point, indicating you are now in a text region. This box is called a text box. It grows as you enter text.

- Type **`Equations of motion`**. Mathcad shows the text in the worksheet, next to the equations.

Tip If you click in blank space in the worksheet and start typing, which creates a math region, Mathcad automatically converts the math region to a text region when you press [**`Space`**].

To enter a second line of text, just press [↵] and continue typing:

- Press [↵].
- Then type **`for falling body under gravity.`**
- Click in a different spot in the worksheet or press [**`Shift`**][↵] to move out of the text region. The text box disappears and the cursor appears as a small crosshair.



Note Use [**`Ctrl`**][**`Shift`**][↵] to move out of the text region to a blank space in your worksheet. If you press [↵], Mathcad inserts a line break in the *current* text region instead.

You can set the width of a text region and change the font, size, and style of the text in it. For more information on how to do these things, see Chapter 5, "Working with Text."

Iterative calculations

Mathcad can do repeated or iterative calculations as easily as individual calculations. Mathcad uses a special variable called a *range variable* to perform iteration.

Range variables take on a range of values, such as all the integers from 0 to 10. Whenever a range variable appears in a Mathcad equation, Mathcad calculates the equation not just once, but once for each value of the range variable.

This section describes how to use range variables to do iterative calculations.

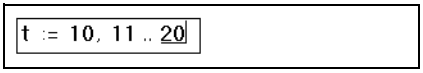
Creating a range variable

To compute equations for a range of values, first create a range variable. In the problem shown in "Calculating results" on page 23, for example, you can compute results for a range of values of *t* from 10 to 20 in steps of 1. To do so, follow these steps:

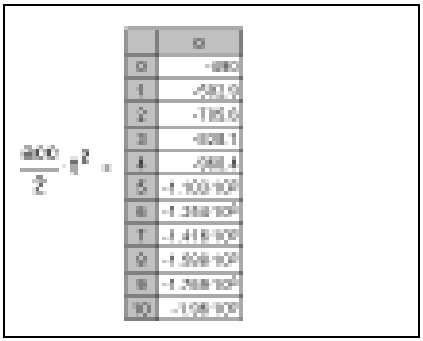
- First, change *t* into a range variable by editing its definition. Click on the **10** in the equation **t:=10**. The insertion point should be next to the 10 as shown on the right.

- Type **, 11**. This tells Mathcad that the next number in the range will be 11.

- Type **;** for the range variable operator, or click  on the Arithmetic toolbar, and then type the last number, **20**. This tells Mathcad that the last number in the range will be 20. Mathcad shows the range variable operator as a pair of dots.



- Now click outside the equation for *t*. Mathcad begins to compute with *t* defined as a range variable. Since *t* now takes on eleven different values, there must also be eleven different answers. These are displayed in an *output table* as shown at right. You may have to resize your window or scroll down to see the whole table.



Defining a function

You can gain additional flexibility by defining functions. Here's how to add a function definition to your worksheet:

- First delete the table. To do so, drag-select the entire region until you've enclosed everything between the two editing lines. Then choose **Cut** from the **Edit** menu or click  on the Standard toolbar.

- Now define the function $d(t)$ by typing **`d(t):`**

$$d(t) := \blacksquare$$

- Complete the definition by typing this expression: **`1600+acc/2`**[**Space**]**`*t^2`**[↵]

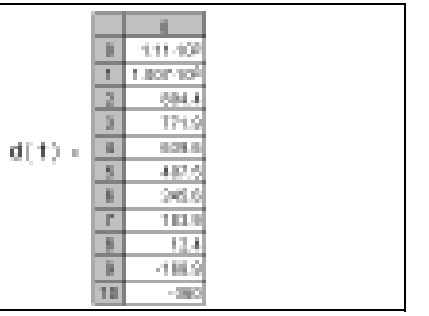
$$d(t) := 1600 + \frac{acc}{2} \cdot t^2$$

The definition you just typed defines a function. The function name is *d*, and the argument of the function is *t*. You can use this function to evaluate the above expression for different values of *t*. To do so, simply replace *t* with an appropriate number. For example:

- To evaluate the function at a particular value, such as 3.5, type **`d(3.5)=`**. Mathcad returns the correct value as shown at right.

$$d(3.5) = 1.54 \cdot 10^3$$

- To evaluate the function once for each value of the range variable *t* you defined earlier, click below the other equations and type **`d(t)=`**. As before, Mathcad shows a table of values, as shown at right.



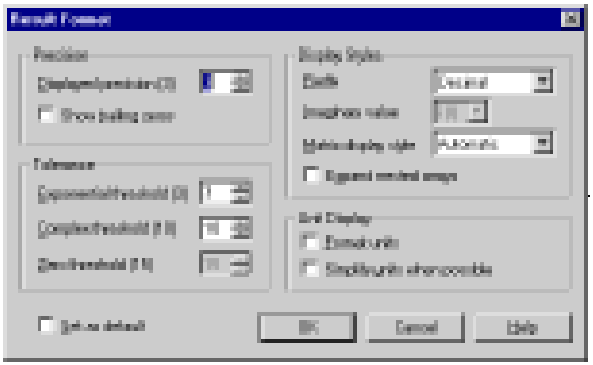
Formatting a result

You can set the display format for any number Mathcad calculates and displays. This means changing the number of decimal places shown, changing exponential notation to ordinary decimal notation, and so on.

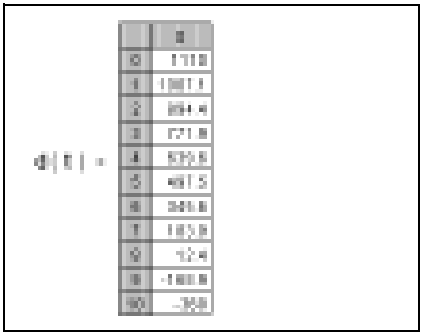
For example, in the example above, the first two values, $1.11 \cdot 10^3$ and $1.007 \cdot 10^3$, are in exponential (powers of 10) notation. Here's how to change the table produced above so that none of the numbers in it are displayed in exponential notation:

- Click anywhere on the table with the mouse.
- Choose **Result** from the **Format** menu. You see the Result Format dialog box. This box contains settings that affect how results are displayed, including the number of decimal places, the use of exponential notation, the radix, and so on.

- The default setting for Exponential Threshold is 3. This means that only numbers greater than or equal to 10^3 are displayed in exponential notation. Click the arrows to the right of the 3 to increase the Exponential Threshold to 6.



- Click "OK." The table changes to reflect the new result format.



Note When you format a result, only the display of the result is affected. Mathcad maintains full precision internally.

Graphs

Mathcad can show both two-dimensional Cartesian and polar graphs, contour plots, surface plots, and a variety of other three-dimensional graphs. These are all examples of *graph regions*.

This section describes how to create a simple two-dimensional graph showing the points calculated in the previous section.

Creating a graph

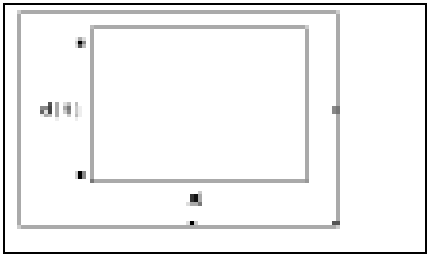
To create an X-Y plot in Mathcad, click in blank space where you want the graph to appear and choose **Graph⇒X-Y Plot** from the **Insert** menu or click  on the Graph toolbar. An empty graph appears with placeholders on the *x*-axis and *y*-axis for the

expressions to be graphed. X-Y and polar plots are ordinarily driven by range variables you define: Mathcad graphs one point for each value of the range variable used in the graph. In most cases you enter the range variable, or an expression depending on the range variable, on the *x*-axis of the plot. But the *QuickPlot* feature in Mathcad lets you plot expressions even when you don't specify the range variable directly in the plot.

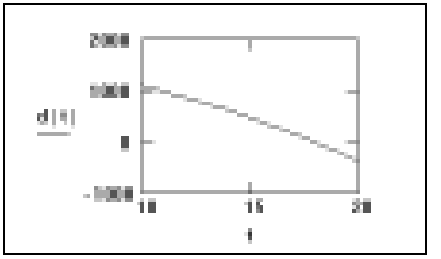
For example, here's how to create a QuickPlot of the function $d(t)$ defined in the previous section:

- Position the crosshair and type **d(t)**. Make sure the editing lines remain displayed on the expression.

- Now choose **Graph⇒X-Y Plot** from the **Insert** menu, or click  on the Graph toolbar. Mathcad displays the frame of the graph.



- Click anywhere outside the graph. Mathcad calculates and graphs the points. A sample line appears under the "$d(t)$." This helps you identify the different curves when you plot more than one function. Unless you specify otherwise, Mathcad draws straight lines between the points and fills in the missing axis limits.



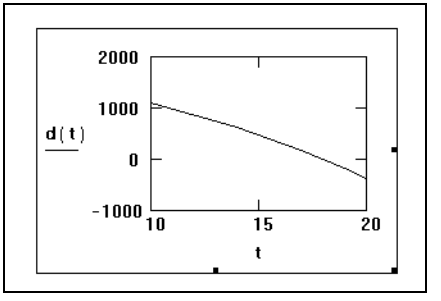
For detailed information on creating and formatting graphs, see Chapter 12, "2D Plots."

Resizing a graph

It's easy to make a graph in Mathcad any size you want: just select the graph and stretch it to the desired size.

To resize a graph, follow these steps:

- Click the mouse just outside the graph and drag the mouse across the plot. A dashed selection rectangle emerges from the anchor point.
- When the selection rectangle just encloses the graph, release the mouse button. The dashed rectangle turns into a solid rectangle with handles.



- Move the mouse pointer to any of the handles. It changes to a double-headed arrow.
- Press and hold down the mouse button. With the mouse button still pressed, move the mouse. The graph is stretched in the direction of motion.
- Once the graphics region is the right size, release the mouse button.
- Click outside the graph to deselect it.

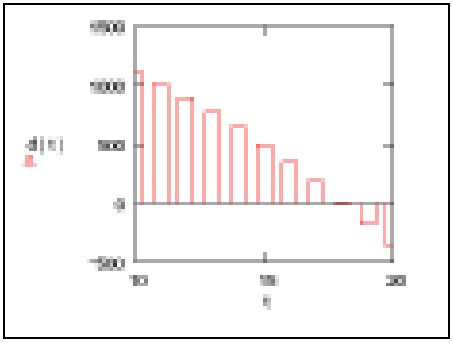
Formatting a graph

When you first create a graph it has *default* characteristics: numbered linear axes, no grid lines, and points connected with solid lines. You can change these characteristics by *formatting* the graph, just as you earlier formatted a numerical result.

To format the graph created previously, follow these steps:

- Choose **Graph⇒X-Y Plot** from the **Format** menu, or double-click the graph to bring up the formatting dialog box. This box contains settings for all available plot format options. To learn more about these settings, see Chapter 12, "2D Plots."

- Click the Traces tab.
- Click "trace 1" in the scrolling list under "Legend Label." Mathcad places the current settings for trace 1 in the boxes under the corresponding columns of the scrolling list.
- Click the arrow under the "Type" column to see a drop-down list of trace types. Select "bar" from this drop-down list.
- Click "OK" to show the result of changing the setting. Mathcad shows the graph as a bar chart instead of connecting the points with lines. Note that the sample line under the $d(t)$ now has a bar on top of it.



- Click outside the graph to deselect it.

Saving, printing, and exiting

Once you've created a worksheet, you will probably want to save or print it.

Saving a worksheet

To save a worksheet:

- Choose **Save** from the **File** menu or click  on the Standard toolbar. If the file has never been saved before, the **Save As** dialog box appears. Otherwise, Mathcad saves the file with no further prompting.
- Type the name of the file in the text box provided. To save to another folder, locate the folder using the Save As dialog box.

By default Mathcad saves the file in Mathcad (MCD) format, but you have the option of saving in other formats, such as RTF and HTML, as a template for future Mathcad worksheets, or in a format compatible with earlier Mathcad versions. For more information, see Chapter 7, "Worksheet Management."

Printing

To print, choose **Print** from the **File** menu or click  on the Standard toolbar. To preview the printed page, choose **Print Preview** from the **File** menu or click  on the Standard toolbar.

For more information on printing, see Chapter 7, "Worksheet Management."

Exiting Mathcad

When you're done using Mathcad, choose **Exit** from the **File** menu. Mathcad closes down all its windows and returns you to the Desktop. If you've made any changes in your worksheets since the last time you saved, a dialog box appears asking if you want to discard or save your changes. If you have moved any toolbars, Mathcad remembers their locations for the next time you open the application.