MathCAD Essentials

Save often! It will crash!

To define or create a function: use colon(:). It will automatically create the correct "equals".

$$y(x) := x*\sin(x)$$

You need y(x) := …, not just y := … (i.e., you must explicitly state your independent variable) The * is automatically replaced with a real multiply ("·"). As expected, use +, –, *, /, and ^. Also, backslash ("\") will create a square root field.

Can also make $a(x,y) := x^2 + y^2$, etc. (multiple independent variables).

To move within an existing equation, use the space bar. The "highlighted" (blue underline) region shows the active space. So, typing "/2" in the following two cases gives different results:

$y(x) := x + \underline{\cos(x)} \quad \rightarrow \quad y(x) := x + \frac{\cos(x)}{2}$

$y(x) := \underline{x + \cos(x)} \quad \rightarrow \quad y(x) := \frac{x + \cos(x)}{2}$

To get a numerical result, use the regular equals:

$2 * \pi = 6.283$
$e - 1 = 1.718$

Note that **e** and **π** are predefined! Don't use e for something else! To obtain any Greek character, type the English equivalent, followed immediately by CTRL-G:

f [CTRL-G] → ϕ p [CTRL-G] → π

Memorize Greek versions of a, b, g, q, f, y, p, and s, at a minimum.

Double click on any numeric result to change the number of sig-figs, or other properties. Note that "undo" will not work on any such changes you make!

Instead of equals or colon, use the arrow (→) to obtain symbolic results. For example, if you have already defined:

$$y(x) := x*x$$

Then typing y(x) → will tell you x^2.
All of these (:=, =, and →) are available on the "evaluation" toolbar.

Units: Symbols can stand for numbers with units. For example, if t = 3s, and v = 2m/s, then

$$x := v \cdot t = 6\ m/s^2$$

Also, unit conversion is "automatic": $5\ kgm^2/s^2 = 5N$

Use "■→" to automatically simplify expressions. Type "simplify" into the square box.

For example: $\boxed{\frac{30-x-x^2}{5-x} \text{ simplify } \rightarrow 6+x}$

Simplification doesn't work all the time, and usually requires your guidance step by step. You'll need to choose subsections to simplify.

Similarly, $\boxed{(5+x)\cdot(2-x) \text{ expand } \rightarrow 10-3\cdot x-x^2}$, and $\boxed{10-3\cdot x-x^2 \text{ factor } \rightarrow (5+x)\cdot(2-x)}$

Atan2(x,y) function: returns atan(y/x), but automatically determines when to add 180° to result.
Magnitude/Absolute Value: Use the Pipe key (above "enter"), or the "calculator" toolbar.

Simple plots (activate View/Toolbars/*Graph* menu).

Use backspace to delete a plot.

Simple X-Y Plot: First define some function, then type it's name into the vertical axis placeholder. Make sure you type in f(x), not just f.
Typing in boundaries is optional. If omitted, MathCAD chooses $0 \le$ horizontal ≤ 10, and uses f(x) to determine a reasonable vertical range.

Contour plot: This is a flat "weathermap". First, define T(x,y). then type T (not T(x,y)!) into the placeholder. To adjust properties, double click, and then:

1. **Quickplot data**. The ranges here are the horizontal and vertical ranges for which MathCAD computes results. They are not to be confused with the limits of the ranges that are displayed, which is controlled by the **Axes** menu. You can add axes names here, too.
   Also, increasing the # of grids increases the smoothness of the plot.
2. Use **Appearance/Fill Contours** to color the plot. Make sure that you show the contour lines!
3. Generally, don't show z-axis number labels.

Surface plot: Change your contour map to a surface plot using the **General** menu (or start from scratch).

1. First, go to **Appearance** and turn off the **wireframe**, changing it to contour lines. Then go to **Special**, and turn off **auto-contour**. Now, you can choose the density of contour lines to match your preferences.
2. You can click and drag directly on the plot to rotate the axes. Or, to go to a specified viewpoint, you can go to General/View. The "top view" angles should be 0°, 90°, and 90°.
3. The zoom is messy, because it messes up the axis labels.

Multi –plots: Example: $\phi = x^2 - y^2$, with $\psi = 2xy$. Make ϕ a contour plot, and ψ a surface plot. Change the line style for ψ at **Special**.

Parametric plot: This plot can be used to plot 3D shapes, and to make plots that don't have rectangular borders. A great use is for plots in cylindrical coordinates. Recall that a surface plot makes $\phi(x, y)$. To use a parametric plot, you make three functions, all of which are functions of the same two independent parameters. For example, you could make the following group:

$$x(r, \theta) = r\cdot\cos(\theta)$$
$$y(r, \theta) = r\cdot\sin(\theta)$$
$$A(r, \theta) = r^2\cdot\sin(\theta) + r$$

Here, we really only want to plot A, but it's hard to use a surface plot since that can only plot on a rectangular x-y grid. The final step is to create a normal surface plot, but with all three functions listed in parenthesis in this order: (x, y, A). The **Quickplot data** submenu now allows you to specify the range for r and θ rather than x and y.

Conditional Functions

Consider a function $V(t) := 10$ if $t < 5$,
$:= 10\cdot e^{-0.7(t-5)}$ if $t > 5$.

You can do this with the "programming" tool bar. First, type "V(t):=". Then, type "add line". Then, move to each row of the resulting group, and click on if. You must put the word "if" in before the expressions themselves! Finally, type in the expressions. It's not a bad idea to leave the "if" out of the first row; that way, if a case comes up where none of your "if" statements is true, this will be the default result. Also, if more than one of your if statements is true, then the function defaults to the last true row listed.

Derivatives and Calculus

Turn on the "calculus" tool bar. It will do derivatives, definite integrals, indefinite integrals, etc., automatically. If it is a function of two variables, derivatives are all treated as partials. Remember, use the arrow ("→") to ask for symbolic results.

$$\frac{d}{dx}x^3 \rightarrow 3\cdot x^2$$
$$f(x, y) := 4\cdot xy + 3\cdot y^2$$
$$\frac{d}{dx}f(x, y) \rightarrow 4\cdot y$$
$$\frac{d}{dy}f(x, y) \rightarrow 4\cdot x + 6\cdot y$$