Quick Tour of Mathcad and Exercises

Mathcad provides a unique and powerful way to work with equations, numbers, tests and graphs.

Features

Arithmetic
Functions
Plot functions
Define your own variables and functions
Visualize data in 2-D and 3-D
Compute sums and integrals
Do matrix computations
Solve equations
  numerically
  symbolically
Programming
Curve fitting and data analysis functions (Handout #2)

Arithmetic, Functions, Calculus, Greek letters, Matrix, Symbolic, Programming etc... can be selected in the Toolbar. (View then Toolbar)

Arithmetic, variables, constants, units, equal signs.

The = sign means to print the value
The : sign means to define a variable [You type : but mathcad prints :=]
The ~ sign means to define a variable before the rest of the work sheet is evaluated
The <cntrl>=, 1 = 1, means to set equal "logically", that is without numerical evaluation.
The .. range operator defines the range in the toolbar or use a semicolon (;)
Typing @ generates a blank graph or use the X-Y Plot button in Graph (Insert or Toolbar).
To separate expressions use the comma operator (, ).

Arithmetic, Functions, Calculus, Greek letters, Matrix, Symbolic, Programming etc ... can be selected in the Toolbar. (View, then Toolbar)

(a). Arithmetic To the right, type the following (NOT IN A TEXT REGION) [For tips on editing and typing expressions, see Editing below.]

\[\frac{2}{3} = \]
\[2*3 = \]
\[2^3 = \]
compare
\[\frac{2}{3} : \]

(b). Now type the following:
\[x:2 \]
\[y:3 \]
\[x/y= \]
\[x^y= \]
\[x^y= \]

(c). Mathcad has several built-in constants. That is, Mathcad "knows" these constants.

Find the values of the following constants by typing
\[e= \]
\[p<\text{Ctrl-g}>= \]
[This means type p and hold down the Ctrl key while you press g.]
\[R= \]

Note that R is NOT the gas constant.

Editing: Correcting a typing error: place the mouse just to the right of the wrong character or symbol.
Click and press the delete (back arrow) key. Try this: change 3 to 9 in the math expressions you created at left.

Editing:
Whole mathcad expressions or text regions can be removed. Just select the desired region and press the delete or backspace key. There are two ways to select a region.
Either click and drag into the region, or click once in the region and press <up arrow> repeating until whole region is outlined.

Editing:
Expressions can be edited for variables and constants or for operators. To remove (and replace) and operator, click on the expression and use the up-arrow or down-arrow to select the part of the expression that contains the offending operator. (blue editing line)
Press the back-arrow to remove it and press the desired operator key to replace it.
**Arithmetic:**
\[
\frac{197}{13} = 15.154 \quad \quad 13^7 = 6.275 \times 10^7 \quad \quad \sqrt{\frac{1.837 \times 10^2}{50 + 6^5}} = 0.153
\]
\[
\prod_{j=1}^{5} \sum_{i=1}^{j} \frac{1}{i} = 13.082
\]

**Functions:**
\[
\log(145) \cdot \cos\left(\frac{3}{5} \cdot \pi\right) = -0.668
\]

**Complex numbers**
\[
(5.1 + 4i)^2 + e^{3-2i} = 1.651 + 22.536i
\]

**Units:**
\[
\frac{1250 \text{ km}}{1.5 \text{ hr}} = 231.481 \frac{\text{ m}}{\text{ s}} \quad \text{change units directly to mph}
\]

**Function and Plot:**
\[
z := 0, 0.5 \ldots 4 \quad \quad f(z) := \sin(z)
\]

<table>
<thead>
<tr>
<th>( z )</th>
<th>( f(z) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>0.500</td>
<td>0.479</td>
</tr>
<tr>
<td>1.000</td>
<td>0.841</td>
</tr>
<tr>
<td>1.500</td>
<td>0.997</td>
</tr>
<tr>
<td>2.000</td>
<td>0.909</td>
</tr>
<tr>
<td>2.500</td>
<td>0.598</td>
</tr>
<tr>
<td>3.000</td>
<td>0.141</td>
</tr>
<tr>
<td>3.500</td>
<td>-0.351</td>
</tr>
<tr>
<td>4.000</td>
<td>-0.757</td>
</tr>
</tbody>
</table>

```
\begin{figure}
\centering
\includegraphics[width=\textwidth]{plot.png}
\caption{Graph of \( f(z) \) and \( \exp(f(z)) \cdot z \) against \( z \).}
\end{figure}
```
Variables and your own functions:

\[ a := 4 \]
\[ a \cdot 5 + \frac{2}{3} \sqrt{a} = 21.587 \]

Or

\[ f(x) := \frac{\sin(x)}{\frac{x}{a^3}} \]
\[ f(1) = 53.854 \]
\[ f(10) = -3.482 \]

Calculus:

\[ \sum_{n=0}^{12} \frac{1}{n!} = 2.718 \]
\[ \int_{0}^{1} \frac{1}{1 + \frac{3}{\sqrt{x}}} \, dx = 0.579 \]

Matrix

\[ A := \begin{pmatrix} 4 & 5 & 1 \\ 5 & 0 & -2 \\ -1 & 2 & 8 \end{pmatrix} \]

Inverse matrix

\[ A^{-1} = \begin{pmatrix} -0.024 & 0.232 & 0.061 \\ 0.232 & -0.201 & -0.079 \\ -0.061 & 0.079 & 0.152 \end{pmatrix} \]

\[ A \cdot A^{-1} = \begin{pmatrix} 1.000 & -6.939 \times 10^{-17} & -2.776 \times 10^{-17} \\ 1.388 \times 10^{-17} & 1.000 & 0.000 \\ 5.551 \times 10^{-17} & 0.000 & \text{determinant} 1.000 \end{pmatrix} \]

\[ |A| = -164.000 \]

\[ B := \begin{pmatrix} 1 & 2 \\ 4 & 6 \end{pmatrix} \]
\[ C := \begin{pmatrix} 3 & 7 \\ -3 & -2 \end{pmatrix} \]

\[ B \cdot C = \begin{pmatrix} -3.000 & 3.000 \\ -6.000 & 16.000 \end{pmatrix} \]
\[ B - C = \begin{pmatrix} -2.000 & -5.000 \\ 7.000 & 8.000 \end{pmatrix} \]

\[ \frac{B}{C} = \begin{pmatrix} 0.267 & -0.067 \\ 0.667 & -0.667 \end{pmatrix} \]
Solving Equations:

Numerically

\[ t := 3 \]

\[ \text{root}(t^{2} - \cosh(t), t) = 2.594 \]

Symbolically using "solve"

\[ x1 + 1 = \frac{1}{x1} \]

\[ \text{solve}, x1 \rightarrow \left\{ \frac{1}{2} \cdot 5^{\frac{1}{2}} - \frac{1}{2}, \frac{-1}{2} - \frac{1}{2} \cdot 5^{\frac{1}{2}} \right\} \]

\[ \sum_{i=1}^{n} i^2 \rightarrow \frac{1}{3} \cdot (n + 1)^3 - \frac{1}{2} \cdot (n + 1)^2 + \frac{1}{6} \cdot n + \frac{1}{6} \]

change the value of \( n \) in the Sum symbol

Precautions

1. Numerical formatting: Under Format and Result there are three parameters that you have to be careful about.

   (a) under **Number Format--General** (Number of Decimal Places and Exponential Threshold)

   Number of decimal places determines the number of figures displayed after the decimal (3 default).
   Exponential Threshold determines how large or how small a number can become before the program switches to exponential notation (3 default)

   (b) under **Number Format**, Tolerance determines the size of a number that will be displayed as 0

\[ \text{decimal} = 9 \text{ and zero threshold} = 9 \]

\[ h := 6.626075 \cdot 10^{-34} \]

\[ h3 := h^3 \quad \text{h3} = 2.909 \times 10^{-100} \]

\[ 10^{10} \cdot \text{h3} = 2.909 \times 10^{-90} \]

Largest and smallest numbers are 10^{307} and 10^{-307}
2. Errors:

R is Rankine-scale degree temperature NOT the gas constant

g: acceleration of gravity NOT gram

Second is sec NOT s

Meter (unit of length SI system of unit) is m
In general you should not use (m, sec, gm and K) as variable names.

Kelvin temperature is denoted K therefore if you need to use it as equilibrium constant add a subscript $K_{eq}$ for instance.

Mathcad evaluates expression from left to right and top to bottom.

Each sheet is independent of the others.

Default numbering system for subscripts begins with 0 not 1. $x_0, x_1, ...$