MathCad Basics
(Dr. Tom Co 9/18/2008)

1. **Variables**
   - Use any letter combinations
   - Should start with letter
   - Greek symbols: type letter followed by [ctrl-g] (see Table 1 for correspondence)
     o Alternatively: [view]→[toolbars]→[greek]
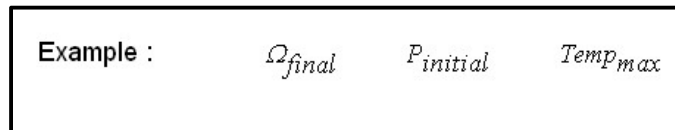   - Can use label-subscripts: type period then the labels

Figure 1. Example of variable labels

2. **Editing mathematical terms and formulas**
   - Special editing keystrokes:
     o **[Spacebar]** – enlarge selections
     o **[Right-cursor]** and **[Left-cursor]** – moves selection
     o **[Insert]** – toggles the insertion position before or after
     o **[ctrl-z]** – undo key (very useful !)
     o **[Backspace]** – removes selections to the left side of cursor
     o **[Delete]** – removes selections to the right side of cursor
       ▪ Note: there are 2 types of placeholders:
         i.   for numbers and variables (small filled box)
         ii. for operation symbols (larger open box)

   - Use parenthesis to group terms
     o Typing left-parenthesis followed immediately by right parenthesis will produce a placeholder.
     o Can also use the prime **[']** key to preset parentheses – but not for defining the arguments of functions.
     o To remove parentheses, move to immediate left of the right-parenthesis, then hit **[Delete]** key (or move to immediate right of left-parentheses then hit **[Backspace]** key)

   - For division, use the slash **[/]** key, but also use the **[Cursors]**, **[Space]** and **[Insert]** keys to position where the division occurs. **Tip**: use parenthesis often for dividing groups of terms, they can be removed later using **[Delete]** or **[Backspace]**.

- special math operators include
  - **Calculus:** turn on **[view]→[toolbar]→[calculus]**. For most hotkeys, hover over the symbols. Below are some of the more often used:
    - **[ctrl /]**   for   first order derivative
    - **[ctrl shift /]** for   high order derivative
    - **[ctrl I]**   for   indefinite integral
    - **[&]**   for   definite integral with limits
    - **[ctrl $]**   for   summation with limits
    - **[ctrl #]**   for   product with limits

      (for subscripting indices use the left-square-bracket **"["**
        – do not use the period)

  - Other hot-keys
    - Use backslash **[\]** for square root
    - Use vertical bar **[|]** for absolute value

3. Assignments and Functions
- Use the colon **":"** key to define values or define functions
- The default order of calculation order is from top to bottom, and from left to right
- Arguments are separated by commas and enclosed by parenthesis.
- There are several built-in functions. To search, use **[INSERT]→[Functions...]** menu or **[Ctrl e]** to bring out window. Alternatively, click on HELP button: **[F1]**.
- To evaluate numerically, use the equal **[=]** key.
- To evaluate symbolically, use the **[ctrl .]** key. (or **[ctrl shift .]** key for extra options). (more information below)
- When defining series, first set the index series and then input the values one by one by ending each entry by a comma before the next entry.

4. Text
- End with **[spacebar]** will convert to math to text
- Use **[Format]→[Style]** to change default fonts. (**"Normal style"** is most often used).

- The Greek symbols can also be input by the **[ctrl-g]** method.
- You can also use **[INSERT]→[Math region]** to include math equations and symbols.

5. **Symbolic Manipulation**
   - Use **[ctrl =]** to define equations
   - There are two modes: live symbolic (using key entry) and

     interactive symbolic (using menu)
     - Using **[ctrl shift .]** will allow several keywords to specify evaluation:
       - The **"simplify"** keyword can automatically divide off common terms
       - The **"assume, …"** can help in evaluations, e.g. during integration.
       - Select **[View]→[toolbar]→[Symbolic]** menu to access more items
       - When using multiple operations on live-symbolic, you can use the right-square-bracket **"]"** key to add lines

     - When using the interactive mode (hit **[Alt s]** to drop-down the menu):
       - You can choose also the **[Evaluation Style]** and toggle on or off the **[Evaluate in place]** button.

6. **Units**
   - To access built-in units, either select **[Insert]→[units]** menu or use **[ctrl u]** hotkey For a partial list of available units, refer to Table 2.
   - During definition of constants, simply enter units after the constant (or explicitly type the multiplication **"*"** symbol followed by the units)
   - When a different set of units need to be displayed, put the cursor at the end of the original units, then in the placeholder, type the new units
   - To build user-defined units, define them as a new constant.
   - When plotting variables with units, the coordinates should be normalized, i.e. divided by the units themselves. (more details in the plot section below).
   - For degrees centigrade or degree Fahrenheit, one needs to use [ctrl u] and select these symbols.

7. **Vectorized Operation**
   - Useful for element-by-element operation.
   - First selecting the group of terms to be "vectorized", then key-in [ctrl -]. (An arrow should appear above the selected group)

8. Plots
- Select [Insert]→[Graph]→[x-y plot] menu item.
- There are 3 placeholders each for the x-axis and y-axis, respectively: the low value, the high value and the variable in that axis. If the high and low value placeholders are not filled, then these values will be automatically determined from the plot data
- Several variables can be plotted. Each should be separated by commas.
- By double clicking on the plot, several modifications can be obtained
- Plots can also be resized and moved

9. Importing Data
- There are several types of data that can be imported, including databases, Matlab and Excel files.
- It is advisable, for novices, to use data saved as text files.
- To import text files,
    o Put the cursor in an empty spot in the worksheet.
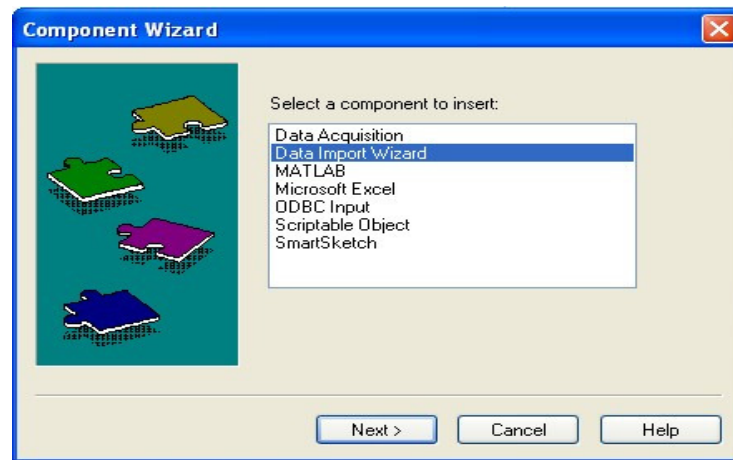   o Select **[Insert]→[Component…]→[Data Import Wizard]**.

Figure 2. Data import wizard window.

    o Choose the files and appropriate types. Also, carefully select the row where the data begins (in case the first row contains the headings).
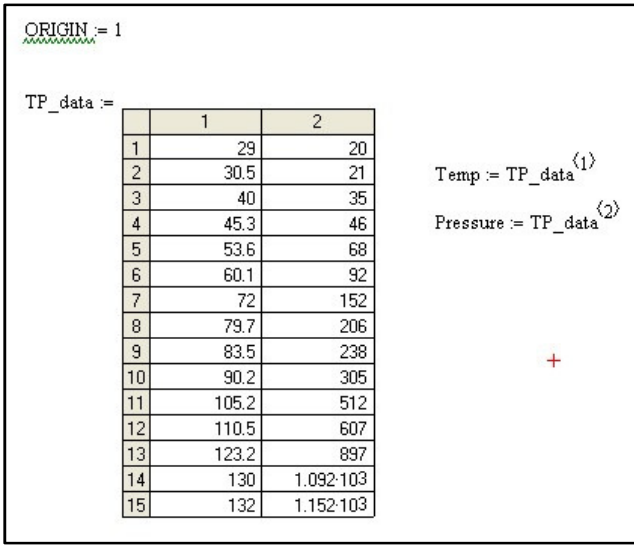   o Type in the name of the variable at the placeholder. (See Figure 3)

ORIGIN := 1

TP_data :=

	1	2
1	29	20
2	30.5	21
3	40	35
4	45.3	46
5	53.6	68
6	60.1	92
7	72	152
8	79.7	206
9	83.5	238
10	90.2	305
11	105.2	512
12	110.5	607
13	123.2	897
14	130	$1.092 \cdot 10^3$
15	132	$1.152 \cdot 10^3$

$Temp := TP\_data^{\langle 1 \rangle}$

$Pressure := TP\_data^{\langle 2 \rangle}$

Figure 3. After importing data.

- o To extract the columns, locate the cursor at the end of the data array variable then key-in **[Ctrl 6]** and supply the column needed. (See Figure 3).

10. Exporting Data

- There are several types of data that can be exported, but it is also advisable at this point to learn how to export data as text files.
- To export text files:
  - o First collect the columns into an array by using the augment function. (See Figure 4)

Temp =		1
	1	29
	2	30.5
	3	40
	4	45.3

Pressure =		1
	1	20
	2	21
	3	35
	4	46

New_Data := augment(Temp,Pressure)

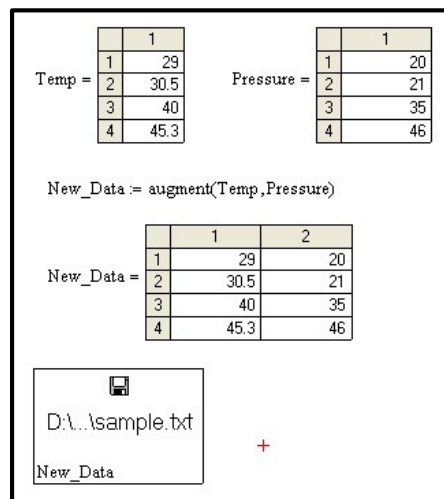| New_Data =		1	2
	1	29	20
	2	30.5	21
	3	40	35
	4	45.3	46

💾
D:\...\sample.txt

New_Data

Figure 4. Augment column before exporting data.

- o Select **[Insert]→[Data]→[File Output...]** menu
- o Choose the file name and other settings
- o A box will appear, with a placeholder below the file name.
- o Type in the array variable name that contains the data (see Figure 4).

Table 1. SYMBOL/GREEK FONT EQUIVALENCE

a	α	n	ν	A	A	N	N
b	β	o	ο	B	B	O	O
c	χ	p	π	C	Χ	P	Π
d	δ	q	θ	D	Δ	Q	Θ
e	ε	r	ρ	E	E	R	Ρ
f	φ	s	σ	F	Φ	S	Σ
g	γ	t	τ	G	Γ	T	T
h	η	u	υ	H	H	U	Υ
i	ι	v	ϖ	I	I	V	ς
j	φ	W	ω	J	ϑ	W	Ω
k	κ	X	ξ	K	K	X	Ξ
l	λ	Y	ψ	L	Λ	Y	Ψ
m	μ	Z	ζ	M	M	Z	Z

Table 2. Built-in Units in MathCad

	Mcad Units	Description		Mcad Units	Description
Length	Angstrom	Angstrom	**Force**	N	Newton
	cm	Centimeter		kN	Kilonewton
	ft	Feet		kgf	kilogram-force
	in	Inches		dyne	Dyne
	km	Kilometer		lbf	pound-force
	m	Meter		tonf	ton-force
	μm	micrometer	**Pressure**	atm	Atmosphere
	mm	Millimeter		Bar	Bar
	nm	Nanometer		Pa	Pascal
	Ml	Mile		MPa	Megapascal
	Yd	Yard		GPa	Gigapascal
Mass	Gm	Gram		in_Hg	inches mercury
	Kg	Kilogram		psi	pounds per inch^2
	Mg	Milligram		psf	pounds per foot^2
	Tone	metric ton		torr	Torr
	ton	Ton	**Energy**	J, joule	Joule
	Oz	Ounce		Cal	Calorie
	Lb	Pound		kcal	Kilocalorie
Time	s, sec	Second		BTU	British thermal unit
	Min	Minutes		erg	Erg
	Hr	Hour	**Power**	Hp	Horsepower
	Day	Day		W	Watts
	Yr	Year		kW	Kilowatts
	Ms	Millisecond		MW	Megawatts
	μs	microsecond	**Temperature**	K	Kelvin
Sub-stance	mol, mole	Mole		R	Rankine
Volume	l, L, liter	Liters	**velocity**	kph	kilometers per hour
	Ml	Milliliter		Knot	Knot
	Gal	Gallon		Mph	miles per hour
	fl_oz	fluid ounce		C	speed of light
Vol Flow Rate	Gpm	gallons per minute	**viscosity**	poise	Poise
				stokes	Stokes

Table 2. Built-in Units in MathCad (continued)

Angles	rad	radians
	deg	degrees
Electric Potential	V	volts
	kV	kilovolts
	mV	milivolts
Electic Charge	C, coul	coulumb
Electric Current	A	amperes
	kA, KA	kiloamperes
	mA	miliamperes
	μA	microamperes
Electric Resistance	ohm, Ω	ohms
	kΩ, KΩ	Kilo-ohm
	MΩ	megaohm
Electric Capacitance	F	Farads
	μF	microfarads
	nF	nanofarads
	pF	picofarads
Electric Inductance	H	Henrys
	mH	Milihenrys
	μH	Microhenrys
Frequency	Hz	Hertz
	kHz, KHz	Kilohertz
	MHz	Megahertz
	GHz	Gigahertz