

## Building Mathematical Expressions SMath Studio Tutorial 3

To facilitate you learning the software I have modified several tutorials from a university class on SMath that should provide the quickest way to learn the software. There is also several hard copies of the official "SMath Suite Primer" for you to use in class. If you wish your own copy you can download a PDF at: <http://people.stfx.ca/bliengme/smath/SmathPrimer.pdf>

These tutorials are designed to give you an introduction to the use of SMath. This software will not only be useful for this class but also any other science class you take that involves the use of mathematics. Open up SMath from the desktop icon or from the start menu click all programs and click on the SMath icon. Follow the instructions below and when you are done email me the worksheet for grading.

- Important Functions:** The examples above include some particular character sequences, namely:
  - sqrt to enter the square root symbol
  - <Cntl+G> to enter Greek letters
  - <space bar> to select wider expressions or expressions between parentheses.
 Another important typing sequence is the use of the right-arrow key in your keyboard. Its action is similar to that of the space bar, namely, to select wider expressions or expressions between parentheses.

The above action will make your use of SMath simpler over the long term.

- Two Dimensional Mathematical Expressions:** The mathematical expressions produced by SMath are referred to as two-dimensional (2D) math, namely, exponents, fractions, etc., will be shown in their proper place as in textbook style. On a new worksheet enter the following:

t <Cntl+G> : t <Cntl+G>.0+a <Cntl+G>.c \* (T.f-T.0 <space bar> <space bar> / sqrt(1+ abs( D <Cntl+G> T /b <Cntl+G> <space bar> <space bar> ^3 <space bar> <space bar> <space bar> ^ 3/2

This example shows the use of Greek letters (Cntl+G), parentheses, space bar, subscripted variables, sqrt (square root), and abs (absolute value) in a 2D mathematical expressions. With practice you will learn to build complex 2D mathematics in SMath Studio. Here is what your equation should look like:

$$\tau = \tau_0 + \alpha_c \left( \frac{\left( T_f - T_0 \right)}{\sqrt{1 + \left| \frac{\Delta T}{\beta} \right|^3}} \right)^{\frac{3}{2}}$$

- Correcting Errors:** Correcting errors in entering an expression can be accomplished in many ways:
  - 1 - Use the Backspace key to remove the last key stroke(s).
  - 2 - Select elements to be removed using your mouse, then the Backspace key.
  - 3 - Click on a specific location to insert variables or expressions.
  - 4 - You can copy and paste an expression within another expression.

Make a copy of the above equation and change the following:

Change  $T_f$  to  $v_f$  and  $DT$  to  $v_2$

- Using the Boolean equal sign:** The example above is an assignment statement. The variables in the right-hand side of the assignment statement should be available beforehand in order for this statement to produce a result. In this example those variables are undefined. If you click on the expression `d=` to the right the message "d.0 – not defined" will be shown. Sometimes you need to type an expression not with the purpose of evaluating it, but with the purpose of documenting an assignment or report. In such case, you can use the Boolean equal sign (first sign in the "Boolean" palette in the right-hand side panel in the SMath Studio interface, also entered by using `Cntl+=`) to build your non-evaluating mathematical expression. Thus, you could type, for example:

`t <Cntl+G> <Cntl+=> t <Cntl+G>.0+a <Cntl+G>.c * (T.f-T.0 <space bar> <space bar> / sqrt(1+ abs( D <Cntl+G> T /b <Cntl+G> <space bar> <space bar> ^3 <space bar> <space bar> <space bar> ^ 3/2`

The result is simply a mathematical expression that includes no evaluations.

- Using the Boolean equal sign with function "solve":** One other use of the Boolean equal sign is to build a mathematical equation to be solved using function "solve". For example, the quadratic equation (follow along by entering these equations on your worksheet):

$$a \cdot x^2 + b \cdot x + c = 0 \text{ has the well-known solution } x = \frac{-b \pm \sqrt{b^2 - 4 \cdot a \cdot c}}{2 \cdot a}$$

Try entering the following as definitions of a, b and c and finding the solution:

$$a = 2 \quad b = 5 \quad c = -6$$

Now enter the equation:

$$x = \frac{-b \pm \sqrt{b^2 - 4 \cdot a \cdot c}}{2 \cdot a}$$

Now use the equals sign to find the answer you should get, clearly not the answer we want:

$$x = \frac{\begin{cases} -5 + \sqrt{73} \\ -(5 + \sqrt{73}) \end{cases}}{4}$$

To get the correct answer we are looking for we need to tell SMath to give you the real roots of the expression. To do this click on the  $f(x)$  button in the menu bar and find solve (2) function, take a second to read the description. Click insert and replace arg1 and arg 2 with x and x respectively. You are telling SMath to use the expression defined as x and solve for variable x. Then `x=` will return the answer we are looking for, see below (you are not including the arrows or comments).

Here we are defining variables  $ax^2 + bx + c = 0$   $x = \frac{-b \pm \sqrt{b^2 - 4 \cdot a \cdot c}}{2 \cdot a}$  This is for documentation only

$a = 2 \quad b = 5 \quad c = -6$

Here we are defining the equation.  $x = \frac{-b \pm \sqrt{b^2 - 4 \cdot a \cdot c}}{2 \cdot a}$   $x = \frac{\begin{cases} -5 + \sqrt{73} \\ -(5 + \sqrt{73}) \end{cases}}{4}$  This is giving a real answer.

Here we are telling SMath we want the roots.  $\text{solve}(x, x)$   $x = \begin{cases} 0.886 \\ -3.386 \end{cases}$  This is giving a roots.

We now have three types of equal signs each with a different meaning:

= the Boolean equality that returns no action

:= will define a variable or equation

= which will return an answer

We also have a modifier to = in the form of "solve (arg1, arg2) that will return real roots.

**Alternative uses of the function solve(2) and solve(4):** An alternative way to solve the quadratic equation used above, namely,  $2x^2 + 5x - 6 = 0$  is to use function "solve". Here we show two different ways to call function "solve", which was introduced above enter the following into your worksheet:

1 - Using function "solve" with two arguments:

$$\text{solve}(2 \cdot x^2 + 5 \cdot x - 6 = 0, x) = \begin{pmatrix} -3.386 \\ 0.886 \end{pmatrix}$$

2 - Using function "solve" with four arguments, limiting the range of the solution:

$$\text{solve}(2 \cdot x^2 + 5 \cdot x - 6 = 0, x, 0, 10) = 0.886$$

In both cases above note the use of the Boolean equals sign as you are just giving an equation. One outputs the two roots. Whereas in two we have restricted the answer to only those between 0 and 10 therefore, the negative root is not displayed. If you want to display the negative root you would enter the following:

$$\text{solve}(2 \cdot x^2 + 5 \cdot x - 6 = 0, x, -10, 0) = -3.386$$

I hope that you are starting to see that the functionality of SMath requires some practice and understanding of how the program works as well as the mathematical functions you are using. If you are missing one of these understandings SMath becomes useless to the operator.

An alternative way to use function "solve" is to assign the function call to a variable, try entering the following:

$x := \text{solve}(2 \cdot x^2 + 5 \cdot x - 6 = 0, x)$  then find the answer by typing  $x :=$ , note that both roots are given.

The "solve" function call can be assigned to another variable, try the following:

$\xi := \text{solve}(2 \cdot x^2 + 5 \cdot x - 6 = 0, x)$  then find the answer. Note that  $\xi$  is found in the symbols pallet.

Once you are done this tutorial please email me your worksheet to receive credit. Then start on assignment 3.