# Tutorial
# Equations

# INTRODUCTION

This chapter has example equations and shows how to type them into ***Expressionist***. At the beginning of each tutorial, there is a final, completed equation that you can use as a guide. Also, each example shows samples of what the screen should look like, step-by-step so that you can easily follow the examples. At every step, make sure that your screen looks like the picture shown. If you find that you have made a simple mistake, you can usually fix it by clicking on the Undo button. Help is always available from the Help menu.

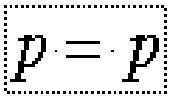
These tutorials assume that you have not changed any preference options from their default settings. If you have made changes, some of the directions may be inappropriate. You can re-install the original preferences file from the ***Expressionist*** disk to return options to their default settings.

# PRESSURE

$$p = p_0 + \rho g h$$

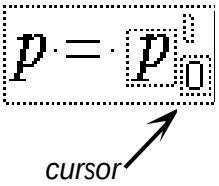
This simple example shows some basic techniques for writing equations.

Start by typing P = P:



Use œ if your keyboard has no esc key.

Select the second *p* by dragging over it or clicking on its middle. To attach a subscript choose the $a_b$ button from the $a^c_b$ pop-up palette. The subscript is selected, so type 0 (zero). Press Ÿ to move the cursor out of the subscript guide box:




This is the pop-up palette of lower-case Greek letters.

Type +. To make the Greek letter rho (not to be confused with *p*) choose the ρ symbol from the palette's α pop-up palette button of lower case Greek letters:

Then type G H:

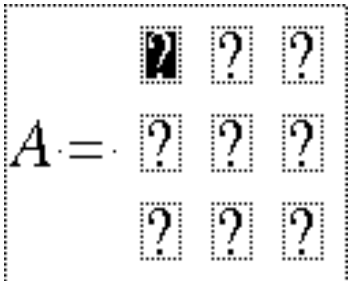
$$p = p_0 + \rho g h$$

# MATRIX

$$A = \begin{pmatrix} \frac{1}{\sqrt{3}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{6}} \\ \frac{1}{\sqrt{3}} & 0 & \frac{2}{\sqrt{6}} \\ \frac{1}{\sqrt{3}} & -\frac{1}{\sqrt{2}} & \frac{1}{\sqrt{6}} \end{pmatrix}$$

In this example, we use a Matrix composite, and use cutting and pasting in conjunction with the various selection tools to make our work easier.

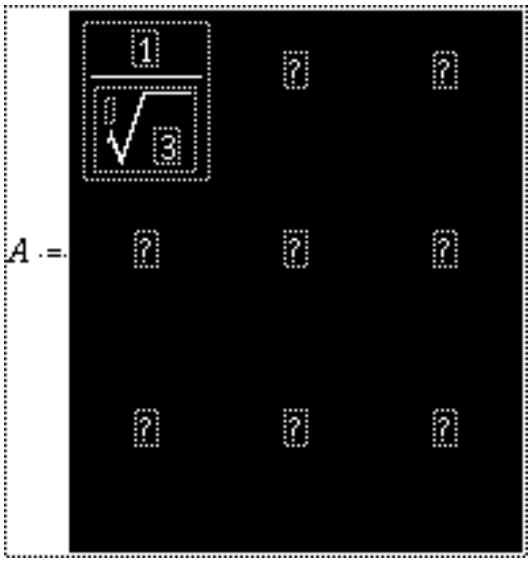
Start by typing ßA =. Then choose  from the  pop-up palette to make a 3 × 3 matrix:



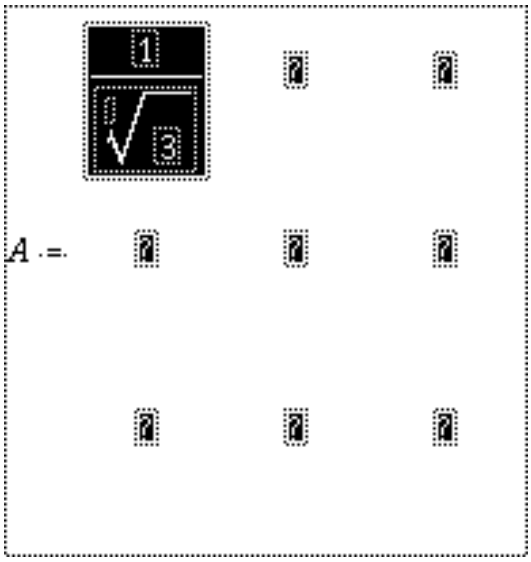
Enter the contents of the first cell (which is already selected): Choose , type 1, click  , choose  from the  pop-up palette, and type 3:

$$\frac{1}{\sqrt[3]{3}}$$

Now, select the entire first matrix element and click  to copy it to the clipboard. Click  to Select Out, which selects the whole matrix,

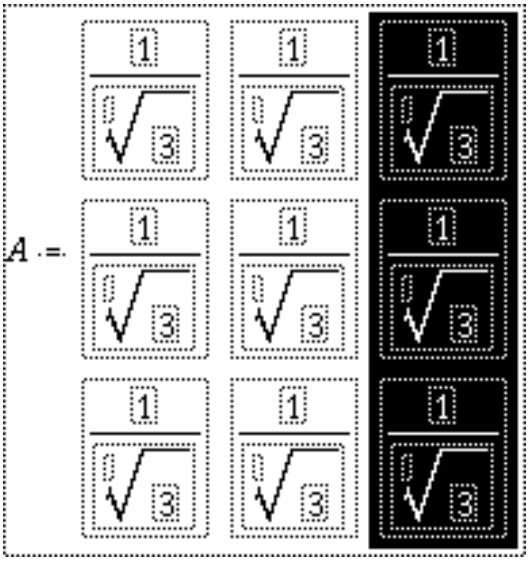



…then click to Select In, which selects all individual matrix cells.

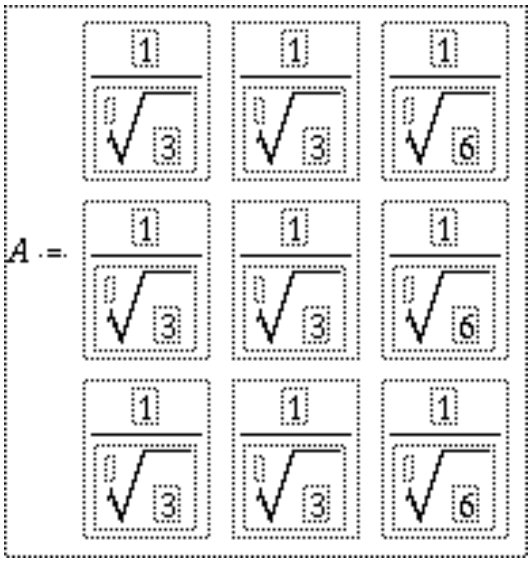


Click  to paste the reciprocal square root into each cell. (Note that if we had selected the whole matrix and pasted, it would have replaced the entire matrix with a single $\frac{1}{\sqrt{3}}$ instead of inserting into each element the way we want.)

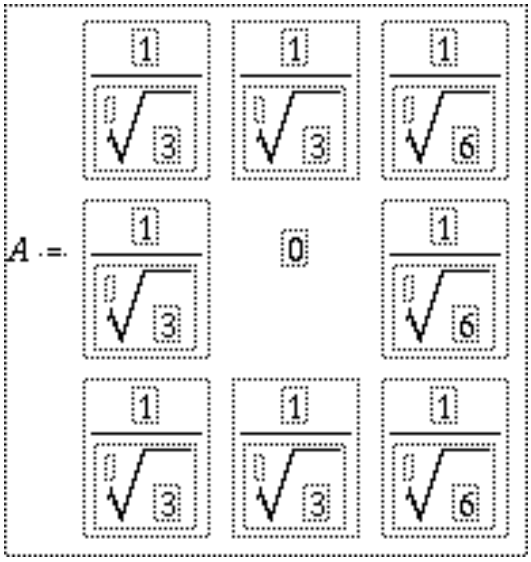
Click and drag to select the entire third column as shown:



Select In . Select First . Select Next . Select First again. Type 6 to replace the selected 3's.

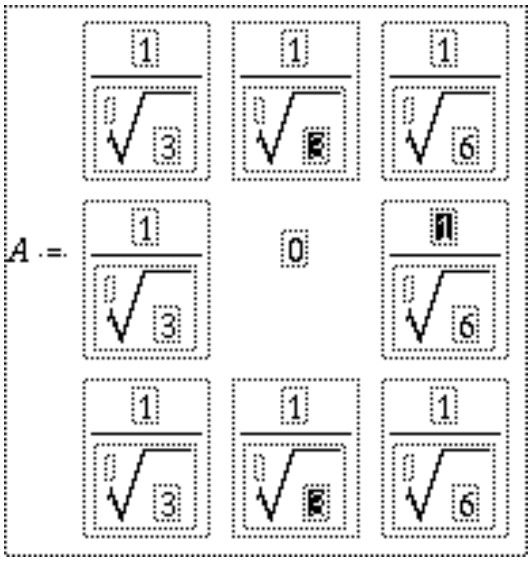


Click and drag to select the center matrix cell, then type 0 (zero).

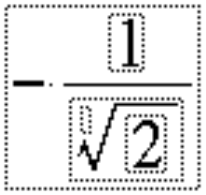


Select the two 3's in the middle column by clicking and dragging over the first 3 then doing the same to the second 3 while pressing the Shift

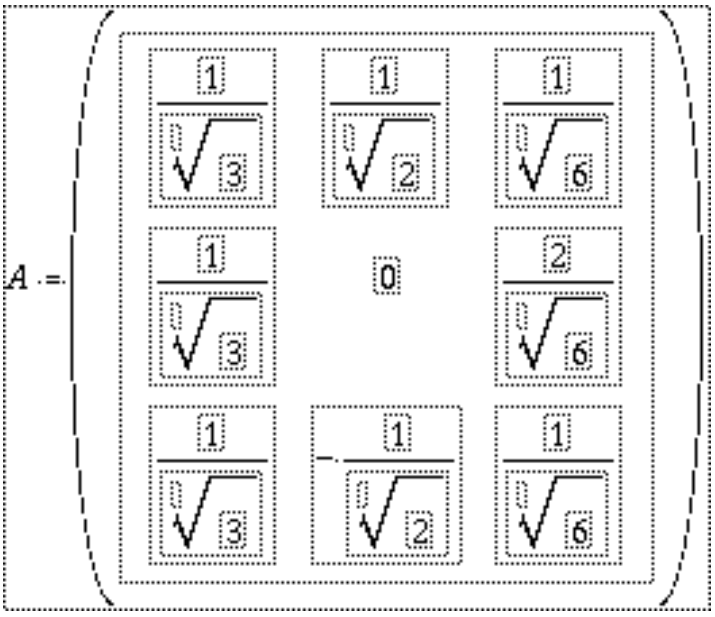
key. Shift-drag over the numerator in the middle cell of the last column. The multiple selection is:



Type 2. Place the cursor at the beginning of the bottom-middle cell, and type - for a minus sign.



Select the whole matrix (by dragging or doing Select Out twice), then choose from the pop-up palette to enclose it in parentheses:



The letter *A* is a *tensor* quantity (higher than a vector), so it should be changed to Arial, a sans serif font. Select the *A* by dragging or clicking on its middle, then click the FontSizeStyle box, *TimesNewRoman* 12 *iv*, change the font family to Arial, change the **Italic** style pop-up menu to **off**, and click **OK**. The equation is complete.

$$A = \begin{pmatrix} \frac{1}{\sqrt{3}} & \frac{1}{\sqrt{2}} & \frac{1}{\sqrt{6}} \\ \frac{1}{\sqrt{3}} & 0 & \frac{2}{\sqrt{6}} \\ \frac{1}{\sqrt{3}} & -\frac{1}{\sqrt{2}} & \frac{1}{\sqrt{6}} \end{pmatrix}$$

# QUANTUM MECHANICS

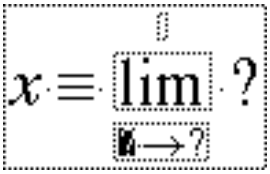
$$x \equiv \lim_{n \to \infty} x_n = y - \frac{\langle b_1 | y \rangle a_1}{1 + \langle b_1 | a_1 \rangle}$$

In this example, we use some keyboard shortcuts and a macro, and also try the Insert Something command.

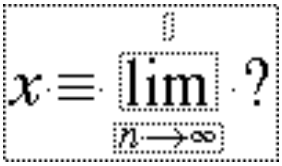
The operators and macros pop-up buttons.

Start by typing X. To insert the ≡ symbol, click and hold on the × pop-up button. When the palette of operators pops up, move the pointer to the ≡ symbol and release the mouse button. To make the limit, choose the $\lim_{\square \to \square}$ macro icon from the $\prod_{n=1}^{\infty}$ pop-up. (Be sure to choose the limit macro with the right arrow, not the left arrow.) macro pop-up

Choosing a macro, inserts it into the expression.



With the above selection, type N, then click and drag over the right ? to select it and click the infinity sign ∞ on the palette.



Select the ? to the right. Type X and press ˚L (çL), which grabs the *x* and attaches a subscript to it. Type N into the subscript. Press Ÿ to move the cursor out and to the right, then type =:

$$x \equiv \lim_{n \to \infty} x_n =$$

Now, type Y -. Press ˚F (çF), or choose $\frac{a}{b}$:

$$x \equiv \lim_{n \to \infty} x_n = y - \frac{?}{?}$$

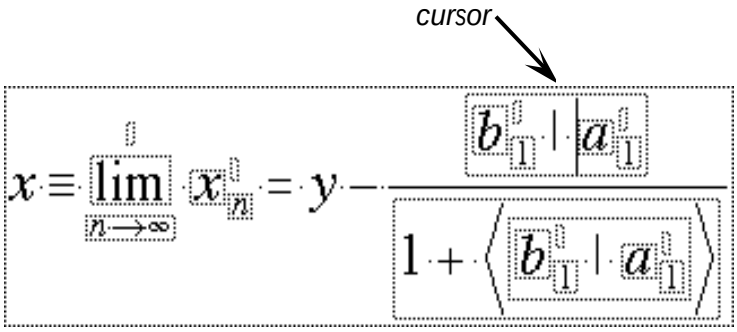
Type ß\ (backslash) for the vertical bar.

Type B ˚L 1 Y ˙ | ˙ A ˚L 1 (use çL instead of ˚L with Windows). Select the whole numerator (either drag or use Select Out $x_1^2$ a few times), copy it to the clipboard, select the denominator, and paste.

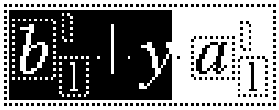
$$x \equiv \lim_{n \to \infty} x_n = y - \frac{b_1 \mid a_1}{b_1 \mid a_1}$$

Select the whole denominator and choose $\langle a \rangle$ from the fences pop-up palette to surround it in angle brackets. Move the cursor to the beginning (left) of the denominator string and type 1 + ˙.

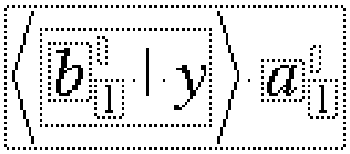
In the numerator, position the cursor as shown below.




Type Y ˙. Click and drag to make the following selection, paying particular attention to the spaces.



Surround this in the angle brackets like you did in the denominator a few steps previously.

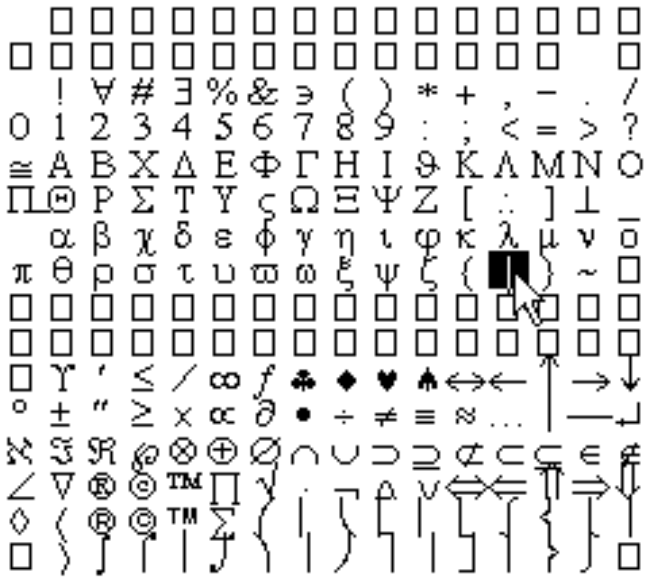


This is what it looks like if we print it out:

$$x \equiv \lim_{n \to \infty} x_n = y - \frac{\langle b_1 \mid y \rangle \, a_1}{1 + \langle b_1 \mid a_1 \rangle}$$

It looks good, except that the vertical bars are somewhat small. Select each bar (that is, so you have a multiple selection) and choose **Insert Something…** from the **Edit** menu. In the ensuing dialog, select the ω Symbol font command from the scroll list.

Below this list is a list of all characters in the Symbol font. Click on the vertical bar as shown below,



…then click the **This Character** button. The Symbol bar is inserted into your equation, replacing the selected original wimpy bars.

$$x \equiv \lim_{n \to \infty} x_n = y - \frac{\langle b_1 | y \rangle a_1}{1 + \langle b_1 | a_1 \rangle}$$

That is more like it!

# ANTENNA

$$\frac{dP}{d\Omega} = \frac{I^2}{2\pi c}\begin{cases} \dfrac{\cos^2\left(\frac{\pi}{2}\cos\theta\right)}{\sin^2\theta}, & kd = \pi \\ \dfrac{4\cos^4\left(\frac{\pi}{2}\cos\theta\right)}{\sin^2\theta}, & kd = 2\pi \end{cases}$$

This example shows how to use a matrix to make rows and columns line up, and the Change command. It also shows how to enter an equation entirely from the keyboard.

First create the leftmost fraction: Press ˚- to make a vertical fraction and type D ßP. Press † to move the selection to the bottom. Type D. To make the Ω, type åßW on a Macintosh or ÅçßW under Windows.

$$\frac{dP}{d\Omega}$$

Press Ÿ to get out of the fraction, and type =. Type ˚- (çF under Windows) to get another fraction. Type in the numerator: ßI ˚H 2 (ßI çH 2). To move the selection to the denominator, press Ÿ then †:

$$\frac{dP}{d\Omega} = \frac{I^2}{\blacksquare}$$

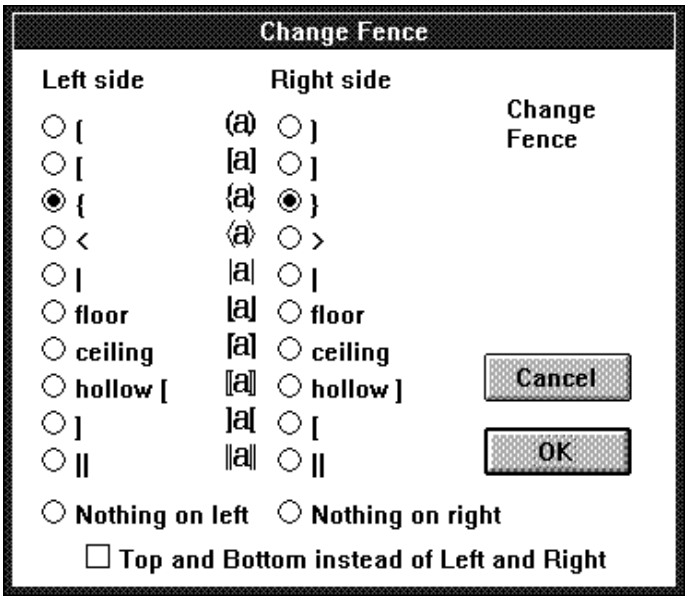
Type 2 åP C (Mac) or ÅçP C Ÿ (Windows).

$$\frac{dP}{d\Omega} = \frac{I_1^2}{2\pi c}$$

Now start on the big, ugly part. First, type ˚ß[ (or ç™)to make a set of curly braces. Press ßŸ, which invokes the Select Out command to select the whole set of braces and their contents.

$$\frac{dP}{d\Omega} = \frac{I_1^2}{2\pi c}$$

The braces are part of a *fence* composite, which surround an expression with a fence style (e.g., bracket, brace, etc.) or combination of fence styles. Invoke the Change command by pressing ˚K (or çK), which brings up the Change Fence dialog.



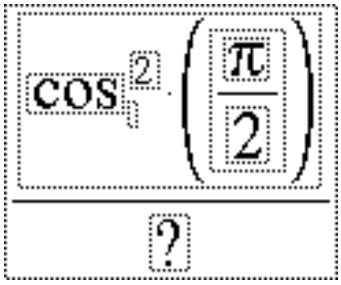
This dialog has many keyboard shortcuts for the various fence styles. Experiment a little.

This dialog lets you change various attributes of the selected fence composite. You can change the fence style, make a fence on one side, or make a fence on the top and/or bottom. You can mix and match fence styles. In this case, we just want a curly brace on the left, so press use the Tab and/or arrow keys to choose **Nothing on right** and press œ.

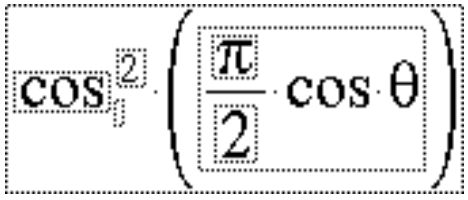
Select the question mark inside the fence by pressing ˚E (or çE). This invokes the Select In command, which selects what is inside the selected structure, and is the opposite of the Select Out command used a few steps previously.

Make a fraction with ˚- (or çF) and type C O S in the numerator. Press ˚H (or çH) to make a superscript for the "cos".


Type 2 for the superscript, then Ÿ to get out of the superscript. Type ˚åß9 (ç¡) to make the parentheses, and inside them make a fraction with ˚- (or çF). Type åP † 2 (or ÅçP † 2) so you have:

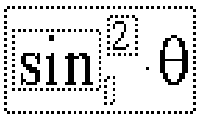



Press Ÿ to get out of the inside fraction, which still leaves the cursor inside the parentheses. Then, type C O S, then ÅÇQ (or åQ) to make a θ. That is it for the top of the fraction:

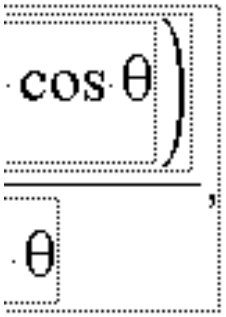


Type ß\ (backslash) for the vertical bar.

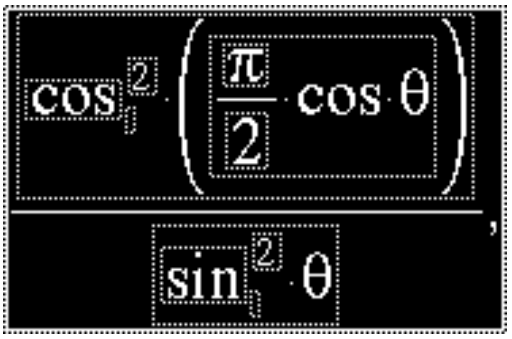
Select the denominator by typing Ÿ †. Type S I N then make a superscript with ÇH. Type 2 Ÿ ÅÇQ (2 Ÿ åQ):



Type Ÿ to go to the end of the big fraction, and press , to insert a comma:



Press ßŸ to Select Out.



Copy it to the clipboard. Press ˇ to move the cursor. Press ˚† (or Åß†) to invoke the New Field command, which adds a matrix column. Press œ for New Line, which adds a matrix row with the bottom-left cell selected. Paste it to the clipboard.

Next, we must make changes in the bottom expression. With the cursor still in the bottom part you just pasted in, press ¯ twice, then press †. Press ¯ to put the cursor just to the left of "cos²", then type 4 ˙ ( or 4). Then, select the superscript 2 by pressing ˇ followed by † twice, and type 4 in its place:

Select the top-right cell of the matrix by typing Ÿ twice and † three times, then type K D = åP (or K D = ÇP) to make:

$$kd = \pi$$

The next part is an exercise for you. Using the keyboard only, select the bottom-right matrix cell and enter the expression "*kd* = 2π". Using the mouse is cheating; bonus points if you copy and paste. You want to end up with

$$\frac{dP}{d\Omega} = \frac{I^2}{2\pi c}\begin{cases} \dfrac{\cos^2\left(\frac{\pi}{2}\cos\theta\right)}{\sin^2\theta}, & kd = \pi \\ \dfrac{4\cos^4\left(\frac{\pi}{2}\cos\theta\right)}{\sin^2\theta}, & kd = 2\pi \end{cases}$$

The equation is complete.

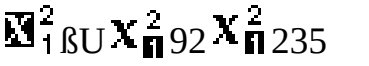
# COOKBOOK EQUATIONS

Now that you have completed the tutorials and acclimated yourself with ***Expressionist***, you can construct equations with a minimum of guidance. For each 'recipe' below, start with a new expression window. If the recipe shows a button, click it. If it shows a key, type it. If it shows a menu item, choose it.

## Uranium Isotope

$$^{235}_{92}U$$

Change prescripts *on*, superscripts and subscripts *off*.



## Eigenvectors

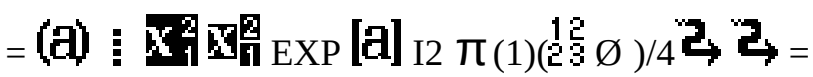
$$\begin{pmatrix} |1\rangle_1 \\ |1\rangle_2 \\ |1\rangle_3 \\ |1\rangle_4 \end{pmatrix} = \begin{pmatrix} \exp\left[i2\pi(1)(1)/4\right] \\ \exp\left[i2\pi(1)(2)/4\right] \\ \exp\left[i2\pi(1)(3)/4\right] \\ \exp\left[i2\pi(1)(4)/4\right] \end{pmatrix} = \begin{pmatrix} i \\ -1 \\ -i \\ 1 \end{pmatrix}$$

Choose **Left Side** and press **OK**.

The $\begin{smallmatrix}1&2\\2&3\end{smallmatrix}$ button is on the pop-up and on the Insert Something dialog.

Pi (π) is on the palette.

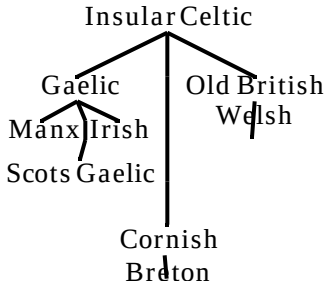
(The cursor disappears after the second Escape, but reappears at the end of the expression when you begin typing…)



(a) ⋮ I $x^2_n$ -1 $x^2_n$ -I $x^2_n$ 1

## Language Tree

Turn off Auto Spacing (from the **Options➧Editing** submenu) before doing this one. Pay attention to the nesting and escape levels as you create this tree. Also notice how the Raise command works.




Macintosh…

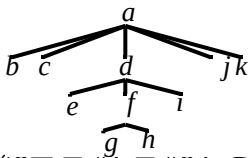
˚ßT **“Insular Celtic”** † ˚ßT **“Gaelic”** † **“Manx”** ˚ß˜ ˚† **“Scots Gaelic”** ˚† **“Irish”** ˚ß˜ Ÿ ˚ß˜ ˚† ˚ßT **“Cornish”** † **“Breton”** Ÿ ˚† ˚ß˜ ˚ßT **“Old British”** † **“Welsh”**

Windows…

ÇP ÇT **“Insular Celtic”** Åß† ÇT **“Gaelic”** Åß† **“Manx”** Å˜ † **“Scots Gaelic”** † Å˜ **“Irish”** Ÿ Å˜ † ÇT **“Cornish”** † **“Breton”** † ƒ ø Ÿ † Å˜ ÇT **“Old British”** † **“Welsh”** † ƒ ø

## Tree

Pay attention to the nesting and escape levels as you create this tree. Also notice which commands backselect the previous string.




Macintosh…

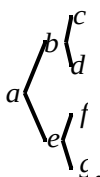
A ˚ß† B ˚† C ˚† D ˚ßT E ˚† F ˚ß† G ˚† H Ÿ ˚† I Ÿ ˚† J ˚† K

Windows…

ÇT A † B † C Åß† ÇT D Åß† E † ÇT F † G † H Ÿ † I Ÿ Åß† J Åß† K

## Sideways Tree

Pay attention to the nesting and escape levels as you create this tree. Also notice which commands backselect.



Macintosh…
A ˚åßT B ˚åßT C ˚† D ç ˇ† E ˘åßT F ˚† G

Windows…
A ÅÇßT B ÅÇßT C Åß† D Ÿ Åß† E ÅÇßT F Åß† G

## Triple Integral

Pay attention to the nesting and escape levels as you create this tree. Also notice which commands backselect.

$$\int_0^1 \int_0^1 \int_0^1 \frac{dx\,dy\,dz}{\sqrt{x^2 + y^2 + z^2}}$$

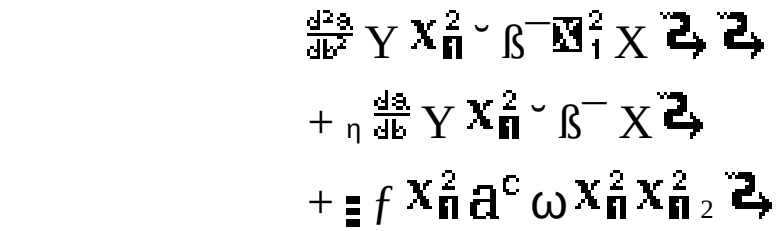
Macintosh…
˚J ƒ † 0 † 1 ßŸ ßŸ ˚C Ÿ ˚V ˚V ß¯ ˚1 ˚F DX ˙ DY ˙ DZ † ˚R X ˚H 2 Ÿ + Y ˚H 2 Ÿ + Z ˚H 2 ˚A

Windows…
ÇJ ƒ † 0 † 1 ßŸ ßŸ ÇC Ÿ ÇV ÇV ß¯ Ó ÇF DX ˙ DY ˙ DZ † ÇR X ÇH 2 Ÿ + Y ÇH 2 Ÿ + Z ÇH 2 ÇA ÅE M

The last two keystrokes drop down the Edit menu and choose Magic Alignment.

## Nonlinear

$$\frac{d^2 y}{d x^2} + \eta \frac{d y}{d x} + \underbrace{\omega^2 \sin x}_{\text{nonlinear part}} = 0$$



S I N X “nonlinear part”

**Allow Uneven Rows OK** = 0

Note the similarity between the “nonlinear part” in the equation above and the “volume weighting” in the expression which follows. Both use different methods to accomplish similar tasks.

## Volume

$$\frac{\vec{w}_i}{\text{volume}} \overset{\text{volume weighting}}{} \omega_{grid} \overset{\text{FFT}}{} \hat{\omega}$$

˚T **(or ÇP for Windows)** W a<sub>b</sub> I

**“volume”**

On the ↔ pop-up.

**Subscripts and Superscripts…** ***off***

**Underscripts and Overscripts…** ***on***

**“volume”** **“weighting”**

ω **“grid”**

£ **Subscripts and Superscripts**

¢ **Underscripts and Overscripts** Ø

**“FFT”**

## Multiple Aligned Lines

$$\begin{aligned}\sin\theta &= -\sin(\theta+\pi)\\ &= -\cos(\theta+\pi/2)\\ &= \cos(\theta+3\pi/2)\end{aligned}$$

Macintosh…

S I N åQ = - S I N ( ăQ + ăP ) œ = - C O S ( åQ + åP / 2 ) œ = C O S ( åQ + 3 åP / 2 ) ˚A ˚K

Align Along This Character

Windows…

S I N ÅÇQ = - S I N ( ÅÇQ + ÅÇP ) œ = - C O S ( ÅÇQ + ÅÇP / 2 ) œ = C O S ( ÅÇQ + 3 ÅÇP / 2 ) ÇA ÇK

Align Along This Character