

# 12

## Formulas (equations)

### **Overview**

Formulas are mathematical objects in FrameMaker, not just graphical objects as in other DTP applications. The construct has many features including mathematical operations. It is possible to evaluate a formula both symbolically and numerically.

A complete list of all mathematical element for keyboard input is derived from the on-line help of FrameMaker.

# Formulas (equations)

A formula (or equation in FrameMaker terms) is a mathematical construct, not just a graphic (as for example, in MS Word). Hence you must follow the inner logic of a formula to develop it.

This script can not provide all the information from the manual. For extensive work with formulas please read the manual!

## Selecting formulas and their elements

A formula is automatically placed into an anchored frame (anchored at insertion point). The formula hereafter is placed in an anchored frame of different properties to display some features of a formula:

$$a = \left( \frac{\sqrt{5} - 1}{2} \right) \cdot b$$

- The framed rectangle is the anchored frame (anchored in the preceding paragraph, alignment left)
- The light gray area denotes the formula. Select the complete formula with **CTRL-click**. Then the formula can be moved around within the anchored frame.
- Select an element of the formula (e.g. the square root symbol) with these methods:
  - Double click on the element.
  - Place the cursor in front of the element and press the **space-bar** once.
  - Sweep the cursor over the element. The amount and direction of movement while sweeping expands the selection of the current formula construct.
- Expand the selection to the higher level construct with the **up-arrow** or the **space-bar**.
- Narrow the selection to an inner element with the **down-arrow**.
- To replace a construct, select it, press backspace to get the question mark (which is selected). Now you enter the new term (or paste a selection).

## In-line formulas

An in-line formula is inserted in an ordinary paragraph, rather than in a paragraph of its own.


## Stand alone formulas (display formulas)

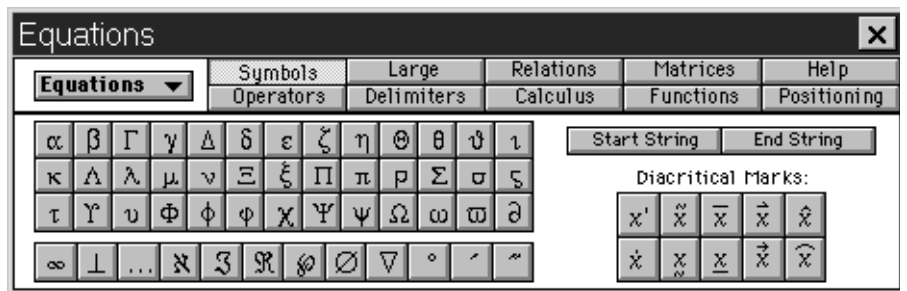
Example formula:  
proportion of the golden  
rectangle

A rectangle with proportions that from classical Greek times has been thought optically pleasing. The relationship between the larger side  $a$  and the shorter side  $b$  of the rectangle is as follows:

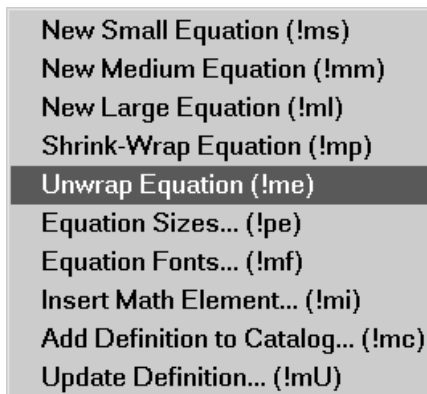
$$a = \left( \frac{\sqrt{5}-1}{2} \right) \cdot b$$

Insert a formula

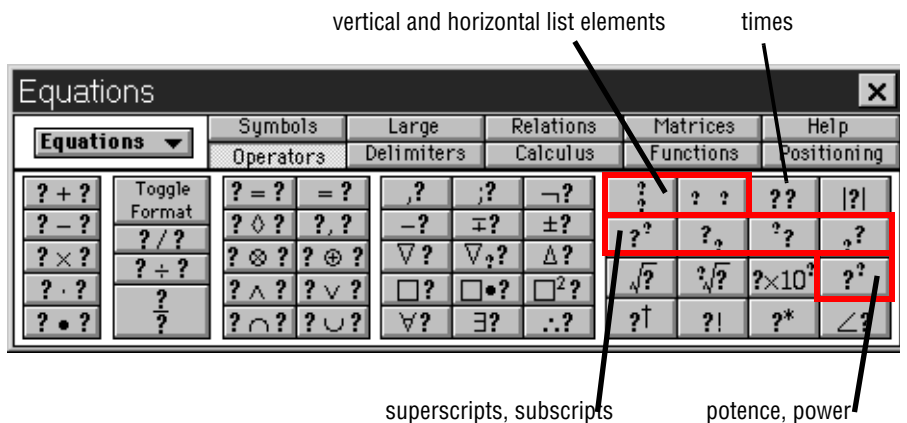
- 1 Place the cursor in an empty paragraph with the basic property "variable line spacing".
- 2 Open the Equation palette ()



- 3 With the button **Equations** select the appropriate size for the new equation (for example, **New Medium Equation**).
- 4 Select **Operators** in the Equations palette and start the formula with operator  $? = ?$  (the first  $?$  will be highlighted, so that you can change it to "a").



In the keyboard short cuts the exclamation mark denotes the ESC character. To unwrap a formula you enter ESC, m, e.



- 5 Select the second  $?$  and replace it by operator square-root; replace the  $?$  under the root by "5".
- 6 Select the square root and apply operator " $? - ?$ "; replace the new  $?$  by "1".
- 7 etc. - by now you should know how to work with this editor ...
- 8 Finally **shrink wrap** the equation (select from the drop down list **Equations**).

Keyboard input vs "mousing"

See *Keyboard input for formula elements* on page 12 for a complete list of keyboard short-cuts. The keyboard input for the sample formula is ( $\_$  denotes a blank,  $!$  denotes a **Return**,  $\rightarrow$  is **Right Arrow**):

$$a = \frac{\sqrt{5} - 1}{2} b$$

## Numbered formulas

Set up a numbered paragraph format with the number appearing at the end of the paragraph.

$$a = \frac{\sqrt{5} - 1}{2} b \quad \text{Formula (2)}$$

|                    |  |
|--------------------|--|
| Format name        | For example fon-formula-numbered.  |
| Basic properties   | Line spacing must be variable ( <i>fixed</i> not checked).<br>Space above and below becomes the space above and below the formula frame, not just around the paragraph text. |
| Numbering property | F:Formula [<n+>]<br>Position "End of Paragraph".   |

## Reference to a numbered formula

If you wish to reference a numbered formula, use a cross-reference style "paranum & page", which might look like this:

<1-highlight><\$paranum><\$paratext><Default ¶ Font> on page <\$pagenum>

Example reference As you can see in *Formula (2)* on page 4, ...

## Create formula in anchored frame

Formulas can be placed directly into an anchored frame:

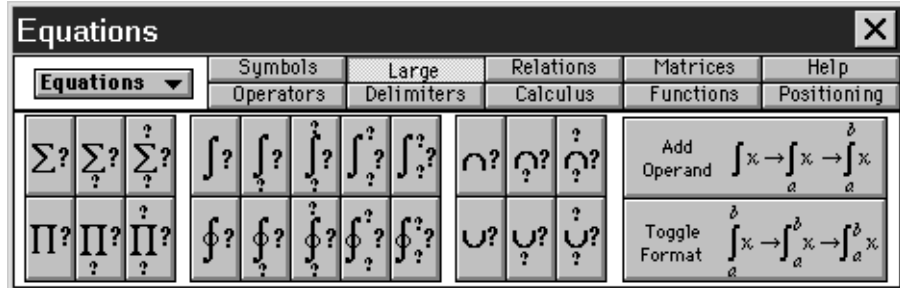
$$\sin x = \sqrt[4]{\frac{\operatorname{asech} \sqrt{5}}{x}} \quad \sum_{\min}^{\max} \sin x = \sqrt[4]{\operatorname{asech} \sqrt{5x}}$$

- 1 Select the frame
- 2 Select formula size from the Equations palette
- 3 Build the equation
- 4 CTRL-click on the formula to select it and move it around
- 5 Add any other elements to the anchored frame (for example, graphics). These may also be in the frame at first.
- 6 Alignment of complete formulas with **Graphics > Align...** acts on the base line of the formula text (the base line of the word "sin" above), not the bounding box of the formula.

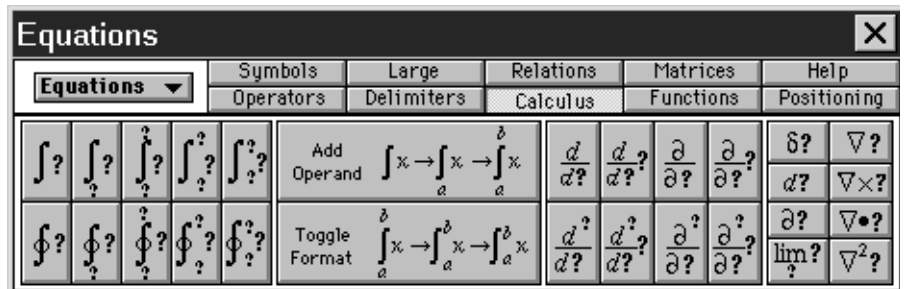
# Palette overview

The Symbols and Operators palette are displayed on page 3.

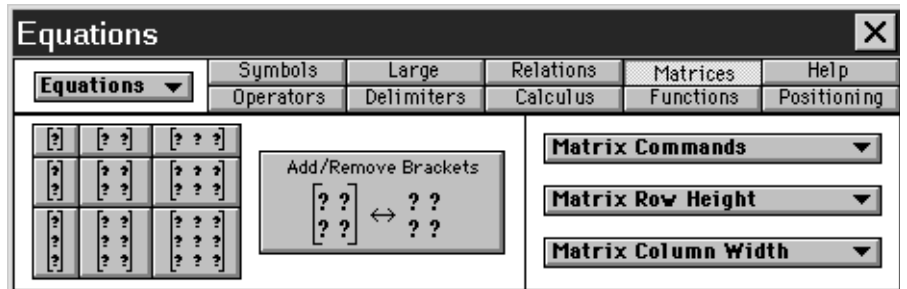
## Large Symbols



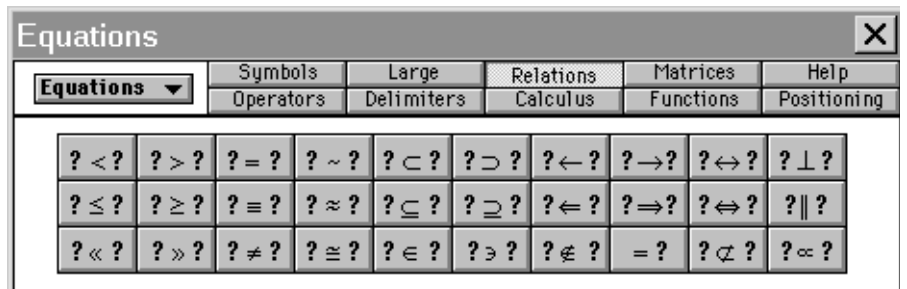
## Calculus



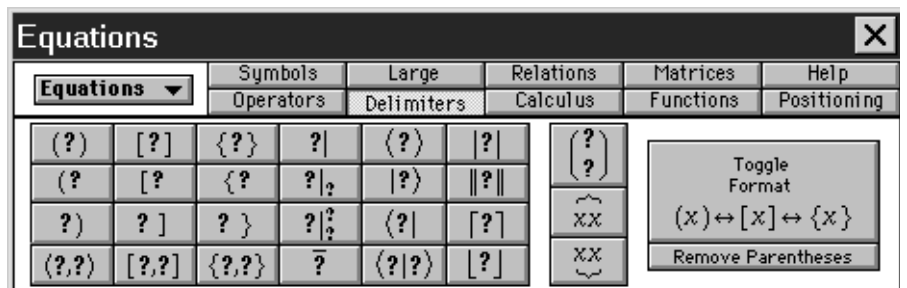
## Matrix



## Relations

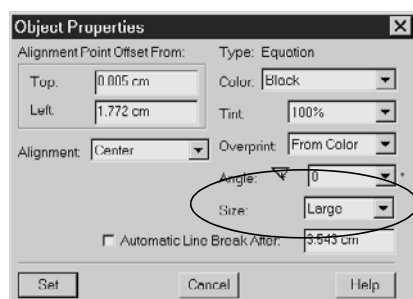


## Delimiters



# Special formatting of formulas

## Resize a formula



When setting up a formula you must choose a size (small, medium, large). To change this afterwards,

- 1 Select the formula. It may be shrink wrapped or expanded.
- 2 Select **Graphics > Object properties**
- 3 Change the size attribute to your desire; **Set!**

## Align formulas

### Align formulas graphically

$$\sin x = 4\sqrt{\frac{\operatorname{asech}\sqrt{b}}{x}}$$

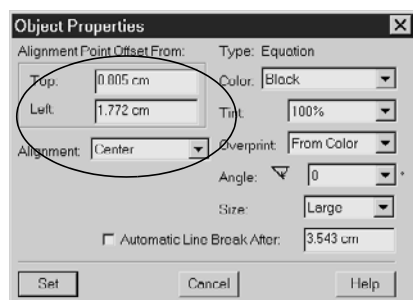
$$\sum_{\min}^{\max} \sin x = 4\sqrt{\operatorname{asech}\sqrt{5x}}$$

Formulas can only be aligned if they are located in the same frame. Hence you may start with a frame and add the formulas to it.

To align the formulas at their boundaries (bounding box) treat the formulas as graphic elements:

- 1 Select the equation (s) which you want to align.
- 2 Select the equation which will be the master for the alignment.
- 3 Choose **Graphics > Align** and set the alignment to your desire.

### Align formulas along special symbol



$$\sin x = 4\sqrt{\frac{\operatorname{asech}\sqrt{b}}{x}}$$

$$\sum_{\min}^{\max} \sin x = 4\sqrt{\operatorname{asech}\sqrt{5x}}$$

To align the formulas along a special point (e.g. the equal sign):

- 1 Click into the first formula to set the alignment point. You may move the alignment point with the **left** or **right** arrow.
- 2 Set the alignment point with the Equations palette **Positioning > Left/Right > Set Manual** or ESC, m, a, s.
- 3 Repeat the above sequence for all formulas in the frame which you want to align.
- 4 To clear an alignment point, select the formula and enter ESC, m, a, d (or choose from the Equations palette **Clear Manual**).
- 5 Select the formula (**CTRL+click**) with the most proper alignment and choose **Graphics > Object Properties**.
- 6 Set the Alignment to **Manual** and set the left position to a memorable value (2.544 → 2.5) or copy the formula to the clipboard.
- 7 Select the next formula to be aligned, with **Object Properties** set Alignment to **Manual** and the left position to the new / copied value.
- 8 Repeat the last operation for all formulas in the frame to be aligned.

## Break long formula into lines

$$(1+x)^8 = x^8 + 8x^7 + 28x^6 + 56x^5 + 70x^4 + 56x^3 + 28x^2 + 8x + 1$$

To break a long formula

$(1+x)^8 = x^8 + 8x^7 + 28x^6 + 56x^5 + 70x^4 + 56x^3 + 28x^2 + 8x + 1$  into lines,

- 1 Place the cursor at the point where you want to break the formula. This can not be between a string (entered with "") and an operator!
- 2 Enter a manual break with Equations palette **Positioning > Line Breaking > Set Manual** or ESC, m, b, s.
- 3 To remove a manual line break, select the preceding and succeeding elements also (e.g.  $70x^4 + 56x^3$ ) and apply ESC, m, b, c or choose from the Equations palette **Clear Manual**.

## Copy and paste formula elements

$$a + \frac{1}{a + \frac{1}{a + \frac{1}{a + \frac{1}{a + \dots}}}}$$

Formulas with 'self repeating' contents can be set up very quickly with the keyboard:

```
ESCm1
1/a+
enter 2 blanks to select the whole formula
copy
press 'arrow right' 3 times to select the ?
paste
press 'arrow right' 3+2 times to select the ?
paste
...
Select the last ? and replace it by \ldots (small L)
```

The formula may not be visible, since it is larger than the initially opened frame. Enlarge the frame to make the complete formula visible, before you shrink wrap it with ESC m p.

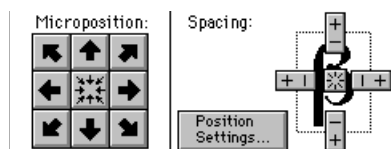
## Physical dimensions and other strings

Physical dimensions are just strings for the FrameMaker Equation editor. They do not bear any mathematical property and hence are not considered in evaluations.

To enter a string into a formula, start the string with a " (straight quote) and terminate it with the Return key (␣). You see two double quotes (") after entering the beginning straight quote. These disappear as soon as you type the first character of the string.

For example, for the first term of the following formula, enter  $v$ "[m/sec]␣. As soon as you close the string with the Return key (␣), the string is selected. To may just continue with the equal sign.

Vehicle speed:  $v[\text{m/sec}] = \frac{s[\text{m}]}{t[\text{sec}]}$  Formula (3)



You may not be satisfied with the space between the variable and the physical dimension. You are tempted to increase this space with positioning or spacing:

$$\text{Vehicle speed: } v \text{ [m/sec]} = \frac{s \text{ [m]}}{t \text{ [sec]}} \quad \text{Formula (4)}$$

This method does not adjust the length of the fraction bar.

### Enter space in formula string

The method of choice is to enter a space as the *first* character in the string:

$$\text{Vehicle speed: } v \text{ [m/sec]} = \frac{s \text{ [m]}}{t \text{ [sec]}} \quad \text{Formula (5)}$$

To enter a thin space, type ESC . . , t. To enter an n-space, type ESC , n , t. The following formula uses n-spaces:

$$\text{Vehicle speed: } v \text{ [m/sec]} = \frac{s \text{ [m]}}{t \text{ [sec]}} \quad \text{Formula (6)}$$

**Note:** *It is very difficult to insert or even change this first blank after you have closed the string! The best method is to remove the string (select and delete) and create it again.*

### Adapt font for strings in formula

To specify a specific appearance of the formula strings, open **Equation palette > Equations > Equation fonts...** and enter a character format for Strings. You can not enter a font name. From the character format only the font property is used. The size is determined by the formula size (large, medium, small).

## Diacritical marks

Two diacritical marks can be stacked one on top of the other. More can be stacked only if the base elements are 'grouped'. The marks which can be elongated (based on a line) are always the lower ones. Tilde, hat, bow and dot are always on top of a line shape.

$$\tilde{\hat{a}} = \widehat{\check{v}xy} \quad \text{Formula (7)}$$

The following marks can be elongated to span more than one base element: overbar, underbar, arrow, half-arrow. These can be stacked according to the base elements.

$$\vec{\overrightarrow{\underline{\underline{a}}}} = \overrightarrow{\underline{\underline{bcde}}} \quad \text{Formula (8)}$$

The others are only placed centred above the spanned elements (see formula 7). These forms are from a font, whereas the lines are drawn as line graphics.

### Remove a diacritical mark

To remove a diacritical mark, select the base element and expand the selection to include the diacritics. Applying the diacritical mark again will remove it (toggle the mark on/off).



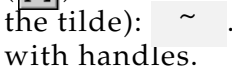
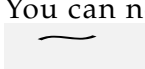
## Special diacritical marks

The capabilities of FrameMaker for handling diacritical marks may not be sufficient for you, e.g. to place an elongated hat or tilde above three elements:

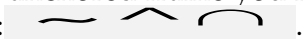
$$\frac{\partial \widehat{uvw}}{\partial x} + \frac{\partial \widetilde{uvw}}{\partial x} = 0$$

Formula (9)

You need a little bit of work to create such constructs:

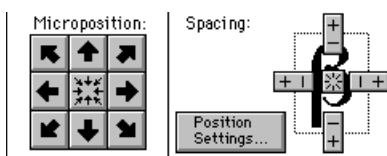
- 1 Create an anchored frame (here filled with gray to display it): 
- 2 With the Graphic-Line tool from the graphics tools palette () create the desired character (as an example, we use the tilde): . You will notice that this is a graphic object with handles.
- 3 You can now elongate it by pulling the right handle: 
- 4 Select the modified symbol (tilde) as a graphic object and copy it into the formula frame:
  - Select the tilde
  - Copy the tilde to the paste buffer
  - Select the formula frame
  - Paste the tilde into the frame
- 5 Move the selected symbol (tilde) to the desired place with the mouse or with CTRL+arrow.

## Working tip

In the anchored frame you may set up a collection of items: .

These symbols can only get character formats. If you need symbols from a special font (such as the last one from the Symbol font, you need to set up an appropriate character format.

## Positioning, finetuning presentation



You may not be satisfied with the space between math elements, the location of exponents and indices etc. Although FrameMaker does a good job, math typesetters and T<sub>E</sub>X experts may have their complaints. In these cases manual work with micro positioning may be necessary.

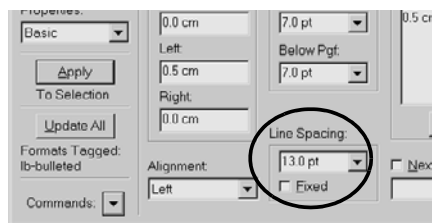
For fine tuning see the manual.

## Editing formulas

- 1 Unwrap the formula (ESC, m, e)
- 2 Place the cursor behind the element you want to edit
- 3 Select the element with **Space bar**
- 4 Modify the element (delete, replace, ...)
- 5 Shrinkwrap formula (esc, m, p)

# Common problems with formulas

## Formula overlaps surrounding paragraphs



The formula construct uses an anchored frame *at insertion point*, which can only expand the paragraph height, if the paragraph has variable Line spacing.

$$a = \left( \frac{\sqrt{5-1}}{2} \right) \cdot b \text{ This is the "formula paragraph".}$$

For paragraphs used as 'anchors' for formulas, the check box for fixed Line Spacing must be *unchecked*.

## Variables are not displayed in italic

If the variables in a formula are not displayed in *italics*, you have accidentally removed the character format **EquationVariables** (English FM) or **GlgVar** (German FM).

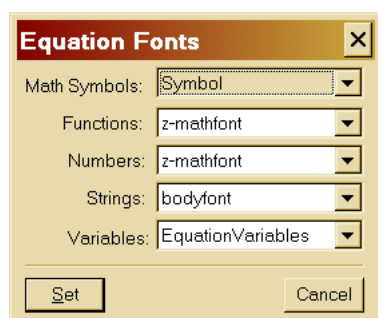
Set up the format again with the properties: Angle = italic; everything else *As Is*. The format must be in the character catalogue.

## Fraction bar has not the desired length

$$\text{Vehicle speed: } v \text{ [m/sec]} = \frac{s \text{ [m]}}{t \text{ [sec]}}$$

The fraction bar can get a correct length only if FrameMaker knows about the length of the elements involved. If you use micro-positioning or spacing, this is just an optical correction. To get correct results, see *Enter space in formula string* on page 8.

## Alternative fonts in formulas



The fonts used in the formulas are defined by character formats. Use the context menu (when in a formula) **Equation Fonts ...** to display the dialogue for setting the font properties.

| Category     | Default                     | Modification needed ...                      |
|--------------|-----------------------------|--|
| Math Symbols | Symbol                      | tweaking maker.ini (and mathchar.cfg)        |
| Functions    | Default ¶ Font <sup>a</sup> | any character format (font family used only) |
| Numbers      | Default ¶ Font <sup>a</sup> | any character format (font family used only) |
| Strings      | Default ¶ Font <sup>a</sup> | any character format (font family used only) |
| Variables    | EquationVariables           | any character format (style used only)       |

a. This document uses character format z-mathfont with specification Helvetica-Light.

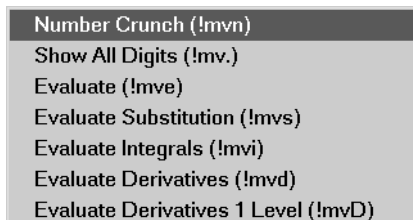
Possible font alternatives for the Math Symbols are: "Lucida New Math", "Mathematical PI Std" or "Universal Standard Greek with Math PI".

**Note:** *Re-defining the fonts may require re-shrinking of all equations! The definition in mathchar.cfg needs some tedious work!*

# Evaluation

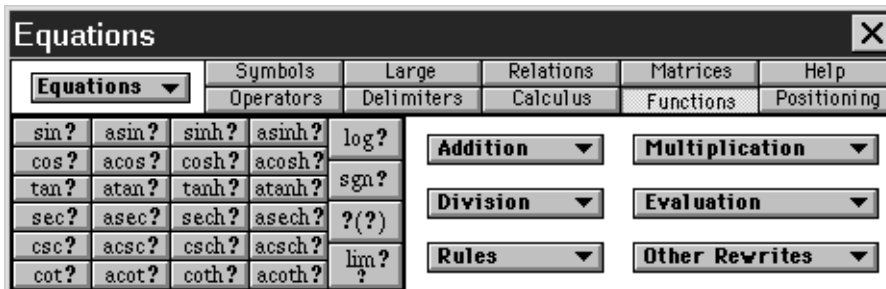
## Numeric results

To evaluate an equation (get numeric results):



To evaluate a formula, for example  $a = \left(\frac{\sqrt{5}-1}{2}\right) \cdot b$ :

- 1 Select the equation inside its frame.
- 2 From the Equations palette choose **Functions > Evaluation > Number crunch**



- 3 You get the following result:  $a = 0.61803399 \cdot b$
- 4 At this stage you may undo the operation to see the algebraic notation again.

## Symbolic evaluation

With **Functions > Evaluations** some expansions are available. To apply an expansion, select the formula (or part of) and then choose the function:

Addition > Add Fractions

$$\frac{a}{4} + \frac{2a}{3} + \frac{7a}{5b} \text{ becomes } \frac{11a}{12} + \frac{7a}{5b} \text{ and then } \frac{55ab + 84a}{60b}$$

Division > Long Division

Numerator and denominator must be polynomials for this function. Select any x in  $\frac{x^5 + 20x^4 + 160x^3 + 640x^2 + 1280x + 1024}{x^2 + 8x + 16}$  and apply the function:  $x^3 + \frac{640x^2 + 1280x + 12x^4 + 144x^3 + 1024}{x^2 + 8x + 16}$  and then  $x^3 + 12x^2 + \frac{1280x + 48x^3 + 448x^2 + 1024}{x^2 + 8x + 16}$

Multiplication > Multiply out

$$y = (x + 4)^5 \text{ becomes } y = x^5 + 20x^4 + 160x^3 + 640x^2 + 1280x + 1024$$

Evaluation > Evaluate

$$(x + 4)^5 \text{ becomes } (x + 4)(x + 4)(x + 4)(x + 4)(x + 4)$$

For even more mathematics see the manual.

# Keyboard input for formula elements

Many maths elements and most functions can be entered via the keyboard.

To enter a Backslash sequence, press **Return** to end the backslash sequence.

Most short-cuts are not localised, so they are valid both for the English and German FrameMaker. The only exception is the input of diacritical marks, which depends on the language.

**Note:** *On a Swiss keyboard some shortcuts are not available (not working). This is because some characters such as tilde are only available as accents on 'dead keys'.*

**Note:** *Some of the sequences listed in the Help for the German FM are wrong. The sequences given here are tested with Windows NT4 and 2000 with a Swiss keyboard. Sequences in shaded cells do not work at all. No correct key sequence could be found for these.*

## Equations pop-up menu

| Command                     | Short-cut      |
|-----------------------------|----------------|
| New Small Equation          | Esc m s        |
| New Medium Equation         | Esc m m        |
| New Large Equation          | Esc m l (lc L) |
| Shrink-Wrap Equation        | Esc m p        |
| Unwrap Equation             | Esc m e        |
| Equation Sizes              | Esc p e        |
| Equation Fonts              | Esc m f        |
| Insert Math Element         | Esc m i        |
| Add Definition to Catalogue | Esc m c        |
| Update Definition           | Esc m U        |

Table 12-1: Equations pop-up menu

## Strings

Strings are single line comments in a formula. To enter them, just start with a single or double apostrophe and enter the text. Terminate with a **Return** (there is no terminating apostrophe).

| Command      | Short-cut |
|--------------|-----------|
| Start String | ' or "    |
| End String   | Return    |

Table 12-2: Entering strings

See example in *Physical dimensions and other strings* on page 7.

# Symbols

## Greek characters

| Element     | Short-cut            | Backslash sequence     |
|-------------|----------------------|------------------------|
| $\alpha$    | Control+Alt+a        | <code>\alpha</code>    |
| $\beta$     | Control+Alt+b        | <code>\beta</code>     |
| $\Gamma$    | Control+Alt+G        | <code>\Gamma</code>    |
| $\gamma$    | Control+Alt+g        | <code>\gamma</code>    |
| $\Delta$    | Control+Alt+D        | <code>\Delta</code>    |
| $\delta$    | Control+Alt+d        | <code>\delta</code>    |
| $\epsilon$  | Control+Alt+e        | <code>\epsilon</code>  |
| $\zeta$     | Control+Alt+z        | <code>\zeta</code>     |
| $\eta$      | Control+Alt+h        | <code>\eta</code>      |
| $\Theta$    | Control+Alt+Q        | <code>\Theta</code>    |
| $\theta$    | Control+Alt+q        | <code>\theta</code>    |
| $\vartheta$ | Control+Alt+J        | <code>\vartheta</code> |
| $\iota$     | Control+Alt+i        | <code>\iota</code>     |
| $\kappa$    | Control+Alt+k        | <code>\kappa</code>    |
| $\Lambda$   | Control+Alt+L        | <code>\Lambda</code>   |
| $\lambda$   | Control+Alt+l (lC L) | <code>\lambda</code>   |
| $\mu$       | Control+Alt+m        | <code>\mu</code>       |
| $\nu$       | Control+Alt+n        | <code>\nu</code>       |
| $\Xi$       | Control+Alt+X        | <code>\Xi</code>       |
| $\xi$       | Control+Alt+x        | <code>\xi</code>       |
| $\Pi$       | Control+Alt+P        | <code>\Pi</code>       |
| $\pi$       | Control+Alt+p        | <code>\pi</code>       |
| $\rho$      | Control+Alt+r        | <code>\rho</code>      |
| $\Sigma$    | Control+Alt+S        | <code>\Sigma</code>    |
| $\sigma$    | Control+Alt+s        | <code>\sigma</code>    |
| $\varsigma$ | Control+Alt+E        | <code>\varsigma</code> |
| $\tau$      | Control+Alt+t        | <code>\tau</code>      |
| $\Upsilon$  | Control+Alt+U        | <code>\Upsilon</code>  |
| $\upsilon$  | Control+Alt+u        | <code>\upsilon</code>  |
| $\Phi$      | Control+Alt+F        | <code>\Phi</code>      |
| $\phi$      | Control+Alt+f        | <code>\phi</code>      |
| $\varphi$   | Control+Alt+j        | <code>\varphi</code>   |
| $\chi$      | Control+Alt+c        | <code>\chi</code>      |
| $\Psi$      | Control+Alt+Y        | <code>\Psi</code>      |
| $\psi$      | Control+Alt+y        | <code>\psi</code>      |
| $\Omega$    | Control+Alt+O        | <code>\Omega</code>    |
| $\omega$    | Control+Alt+o        | <code>\omega</code>    |

Table 12-3: Greek characters

| Element    | Short-cut            | Backslash sequence     |
|------------|----------------------|------------------------|
| $\varpi$   | Control+Alt+l (uc i) | <code>\varpi</code>    |
| $\partial$ | Control+Alt+7        | <code>\cpartial</code> |

Table 12-3: Greek characters

## Other special symbols

| Element     | Short-cut        | Backslash sequence                |
|-------------|------------------|-----------------------------------|
| $\infty$    | Control+Alt+one  | <code>\infty</code>               |
| $\perp$     | Control+Alt+2    | <code>\bot</code>                 |
| $\dots$     | Control+g period | <code>\ldots</code> (lowercase L) |
| $\aleph$    | Control+Alt+3    | <code>\aleph</code>               |
| $\Im$       | Control+Alt+4    | <code>\Im</code>                  |
| $\Re$       | Control+m \$     | <code>\Re</code>                  |
| $\wp$       | Control+Alt+5    | <code>\wp</code>                  |
| $\emptyset$ | Control+Alt+zero | <code>\emptyset</code>            |
| $\nabla$    | Control+Alt+6    | <code>\nabla</code>               |
| $^\circ$    | Control+m )      | <code>\degree</code>              |
| '           | Control+Alt+`    | <code>\prime</code>               |
| "           | Control+m "      | <code>\pprime</code>              |

Table 12-4: Special math symbols

## Diacritical marks

Please note the remarks on page 12 concerning the shaded areas!

| Element                    | Short-cut (FM-E)                        | Short-cut (FM-D)        |
|----------------------------|---|-------------------------|
| $x'$                       | <code>`</code> (grave)                  | <code>`</code> (Grave)  |
| $\tilde{x}$                | <code>~</code> (tilde)                  | <code>~</code> (Tilde)  |
| $\bar{x}$                  | Control+g hyphen<br>Esc m _ (underline) | Control+g hyphen        |
| $\dot{x}$                  | Control+Alt+V                           | Strg+Alt+V              |
| $\hat{x}$                  | Control+g ^                             | Strg+Alt+^              |
| $\dot{x}$                  | period                                  | Punkt                   |
| $\tilde{x}$                | Control+g ~ (tilde)                     | Strg+Alt+~ (tilde)      |
| $\underline{x}$            | Control+g _ (underline)                 | Strg+g _ (underline)    |
| $\overset{\rightarrow}{x}$ | Control+g right arrow                   | Strg+Alt+= <sup>a</sup> |
| $\widehat{x}$              | Control+g @                             | Strg+g @                |

Table 12-5: Diacritical marks in mathematics

a. Control+g right arrow works also in the German FM.

# Operators

Please note the remarks on page 12 concerning the shaded areas!

**Toggle format** switches between the representation of fractions.

| Element              | Short-cut                        | Backslash sequence |
|----------------------|----------------------------------|--------------------|
| ? + ?                | plus                             | \plus              |
| ? - ?                | minus (after an operand)         |                    |
| ? x ?                | Control+m * (asterisk)           | \cross             |
| ? · ?                | Control+m . (period)             | \cdot              |
| ? • ?                | Control+8                        | \bullet            |
| <b>Toggle Format</b> | Control+T<br>Esc m T             |                    |
| ? / ?                | Control+Alt+ /                   | \frac              |
| ? ÷ ?                | Control+m /                      | \div               |
| $\frac{?}{?}$        | /                                | \over              |
| ? = ?                | =                                | \equal             |
| = ?                  | Control+g =                      | \uequal            |
| ? ‡ ?                | Control+j                        | \jotdot            |
| ? , ?                | comma                            | \comma             |
| ? ⊗ ?                | Control+q D                      | \otimes            |
| ? ⊕ ?                | Control+q E                      | \oplus             |
| ? ^ ?                | Control+q Y                      | \wedge             |
| ? ∨ ?                | Control+q Z                      | \vee               |
| ? ∩ ?                | Control+m i                      | \cap               |
| ? ∪ ?                | Control+m u                      | \cup               |
| , ?                  | Control+m , (comma)              | \ucomma            |
| ; ?                  | ; (semicolon)                    | \semicolon         |
| ¬ ?                  | Control+m n                      | \neg               |
| - ?                  | Control+hyphen                   | \minus             |
| ± ?                  | Control+m one                    | \mp                |
| ± ?                  | Control+q one                    | \pm                |
| ∇ ?                  | Control+q Q                      | \grad              |
| ∇ ? ?                | Control+q Q<br>(and add operand) |                    |
| Δ ?                  | Control+m Control+d              | \change            |
| □ ?                  | Control+m x                      | \box               |
| □ • ?                | Control+m o                      | \boxdot            |
| □² ?                 | Control+m 2                      | \box2              |
| ∀ ?                  | Control+m a                      | \forall            |
| ∃ ?                  | Control+m e                      | \exists            |

Table 12-6: Operators

| Element                    | Short-cut                                     | Backslash sequence |
|----------------------------|---|--------------------|
| $\therefore$ ?             | Control+m t                                   | \therefore         |
| ?<br>?                     | Control+a, Esc m v l<br>(l c L)               | \atop              |
| ? ?                        | Control+m ; (semicolon),<br>Esc m h l (l c L) | \list              |
| ? ?                        | * (asterisk)                                  | \times             |
| ?                          | Control+g   (bar)                             | \abs               |
| ? ? (superscript)          | Esc m ^                                       |                    |
| ? ? (subscript)            | Esc m Control+_                               |                    |
| ? ? (superscript in front) | Control+m Control+^                           |                    |
| ? ? (subscript in front)   | Control+m _ (underline)                       |                    |
| $\sqrt{?}$                 | Control+r                                     | \sqrt              |
| $\sqrt[?]{?}$              | Control+r<br>(and add operand)                |                    |
| ? X 10 <sup>?</sup>        | Control+E                                     | \sn                |
| ? ? (exponent)             | ^   | \power             |
| ? †                        | Control+m d                                   | \dagger            |
| ? !                        | !   | \fact              |
| ? *                        | Control+m s                                   | \ast               |
| ∠ ?                        | Control+q P                                   | \angle             |

Table 12-6: Operators

## Large symbols

Use these short-cuts to type each element with only one operand. Then use **Add Operand** and **Toggle Format** as needed

|                  |  |
|------------------|--|
| Add<br>Operand   | $\int x \rightarrow \int_a x \rightarrow \int_a^b x$       |
| Toggle<br>Format | $\int_a^b x \rightarrow \int_a^b x \rightarrow \int_a^b x$ |

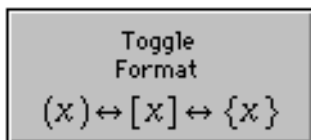
| Element or command | Short-cut          | Backslash sequence |
|--------------------|--------------------|--------------------|
| $\sum$ ?           | Control+S          | \sum               |
| $\prod$ ?          | Control+P          | \prod              |
| $\int$ ?           | Control+i          | \int               |
| $\oint$ ?          | Control+l (uc i)   | \oint              |
| $\bigcap$ ?        | Control+m l (uc i) | \bigcap            |
| $\bigcup$ ?        | Control+m U        | \bigcup            |

Table 12-7: Large math symbols

| Element or command   | Short-cut            | Backslash sequence |
|----------------------|----------------------|--------------------|
| <b>Add Operand</b>   | Control+N<br>Esc m n |                    |
| <b>Toggle Format</b> | Control+T<br>Esc m T |                    |

Table 12-7: Large math symbols

## Delimiters



Use **Toggle Format** to switch between the various types of parentheses.

Apply **Remove Parentheses** only to the selection from which you really want to remove the grouping. To remove only one delimiter (and its mate), place the cursor right to the delimiter and press Delete.

| Element or command | Short-cut                    | Backslash sequence |
|--------------------|------------------------------|--------------------|
| (?)                | (                            | \id                |
| [?]                | [ (left bracket)             |                    |
| {?}                | { (left brace)               |                    |
| ?                  | (bar)                        | \substitution      |
| ⟨?⟩                | Control+m <                  | \dangle            |
| ?                  | Control+g   (bar)            | \abs               |
| (? )               | Control+m (                  | \lparen            |
| [? ]               | Control+m [ (left bracket)   |                    |
| {? }               | Control+m { (left brace)     |                    |
| ? ?                | (bar) (and add operand)      |                    |
| ?⟩                 | Control+m k                  | \ket               |
| ?                  | Control+m   (bar)            | \norm              |
| ? )                | )                            | \rparen            |
| ? ]                | ] (right bracket)            |                    |
| ? }                | } (right brace)              |                    |
| ? ?                | (bar) (and add two operands) |                    |
| ⟨?                 | Control+m b                  | \bra               |
| È?•                | Control+q i                  | \ceil              |
| (?,?)              | Control+m N                  | \inprod            |
| [?,?]              | Control+m C                  | \cmut              |
| {?,?}              | Control+m A                  | \acmut             |
| ̄?                 | _ (underline)                | \overline          |
| ⟨? ?⟩              | Control+m B                  | \bket              |

Table 12-8: Delimiters in formulas

| Element or command        | Short-cut            | Backslash sequence      |
|---------------------------|----------------------|-------------------------|
| $\hat{?}^\circ$           | Control+q k          | <code>\floor</code>     |
| $\binom{?}{?}$            | Control+m h          | <code>\choice</code>    |
| $\underbrace{x}$          | Control+m D          | <code>\downbrace</code> |
| $\overbrace{x}$           | Control+m P          | <code>\upbrace</code>   |
| <b>Toggle Format</b>      | Control+T<br>Esc m T |                         |
| <b>Remove Parentheses</b> | Esc m r p            |                         |

Table 12-8: Delimiters in formulas

## Relation

| Element               | Short-cut                  | Backslash sequence           |
|-----------------------|----------------------------|------------------------------|
| $? < ?$               | <                          | <code>\lessthan</code>       |
| $? > ?$               | >                          | <code>\greaterthan</code>    |
| $? = ?$               | =                          | <code>\equal</code>          |
| $? \sim ?$            | Control+m ~ (tilde)        | <code>\sim</code>            |
| $? \subset ?$         | Control+q L                | <code>\subset</code>         |
| $? \supset ?$         | Control+q I (uc i)         | <code>\supset</code>         |
| $? \leftarrow ?$      | Control+q comma            | <code>\leftarrow</code>      |
| $? \rightarrow ?$     | Control+q period           | <code>\rightarrow</code>     |
| $? \leftrightarrow ?$ | Control+q plus             | <code>\leftrightarrow</code> |
| $? \perp ?$           | Control+m r                | <code>\perp</code>           |
| $? \leq ?$            | Control+g <                | <code>\leq</code>            |
| $? \geq ?$            | Control+g >                | <code>\geq</code>            |
| $? \equiv ?$          | Control+q : (colon)        | <code>\equiv</code>          |
| $? \approx ?$         | Control+q ;<br>(semicolon) | <code>\approx</code>         |
| $? \subseteq ?$       | Control+q J                | <code>\subseteq</code>       |
| $? \supseteq ?$       | Control+q M                | <code>\supseteq</code>       |
| $? \Leftarrow ?$      | Control+q \                | <code>\Leftarrow</code>      |
| $? \Rightarrow ?$     | Control+q ^                | <code>\Rightarrow</code>     |
| $? \Leftrightarrow ?$ | Control+q [                | <code>\Leftrightarrow</code> |
| $? \parallel ?$       | Control+m p                | <code>\parallel</code>       |
| $? \ll ?$             | Control+q I (lc L)         | <code>\ll</code>             |
| $? \gg ?$             | Control+q g                | <code>\gg</code>             |
| $? \neq ?$            | Control+q =                | <code>\neq</code>            |
| $? \cong ?$           | @                          | <code>\cong</code>           |

Table 12-9: Relational operators

| Element           | Short-cut          | Backslash sequence      |
|-------------------|--------------------|-------------------------|
| $? \in ?$         | Control+q N        | <code>\in</code>        |
| $? \ni ?$         | Control+'          | <code>\ni</code>        |
| $? \notin ?$      | Control+q O (uc o) |                         |
| $= ?$             | Control+g =        | <code>\uequal</code>    |
| $? \not\subset ?$ | Control+q K        | <code>\notsubset</code> |
| $? \propto ?$     | Control+q 5        | <code>\propto</code>    |

Table 12-9: Relational operators

## Calculus

Use the first two mentioned short-cuts to type large symbols with only one operand. Then use **Add Operand** and **Toggle Format** as needed.

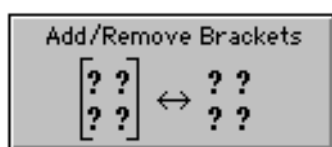
| Element or command               | Short-cut                        | Backslash sequence      |
|----------------------------------|----------------------------------|-------------------------|
| $\int ?$                         | Control+i                        | <code>\int</code>       |
| $\oint ?$                        | Control+l (uc i)                 | <code>\oint</code>      |
| <b>Add Operand</b>               | Control+N<br>Esc m n             |                         |
| <b>Toggle Format</b>             | Control+T<br>Esc m T             |                         |
| $\frac{d}{d?}$                   | Control+g t                      | <code>\optotal</code>   |
| $\frac{d ?}{d?}$                 | Control+g T                      |                         |
| $\frac{\partial}{\partial?}$     | Control+g p                      | <code>\oppartial</code> |
| $\frac{\partial ?}{\partial?}$   | Control+g P                      |                         |
| $\frac{d ?}{d?}$                 | Control+g t<br>(and add operand) |                         |
| $\frac{d ? ?}{d?}$               | Control+g T<br>(and add operand) |                         |
| $\frac{\partial ?}{\partial?}$   | Control+g p<br>(and add operand) |                         |
| $\frac{\partial ? ?}{\partial?}$ | Control+g P<br>(and add operand) |                         |
| $\delta ?$                       | Control+Alt+d                    | <code>\var</code>       |
| $\nabla ?$                       | Control+q Q                      | <code>\grad</code>      |

Table 12-10: Calculus

| Element or command | Short-cut          | Backslash sequence |
|--------------------|--------------------|--------------------|
| $d?$               | Control+d          | \diff              |
| $\nabla x ?$       | Control+m c        | \curl              |
| $\partial ?$       | Control+D          | \partial           |
| $\nabla \bullet ?$ | Control+m v        | \diver             |
| $\lim?$<br>?       | Control+L          | \lim               |
| $\nabla 2 ?$       | Control+m l (lc L) | \lap               |

Table 12-10: Calculus

## Matrices



Pre defined matrices in

**Equations palette > Matrices**



To insert a matrix of any size, first insert a 1 by 1 matrix. Then add rows and columns one at a time. With the Equations palette you have a selection of pre defined matrices available

| Command                                | Short-cut |
|--|-----------|
| Add/Remove Brackets                    | Control+T |
| <b>Matrix Commands pop-up menu</b>     |           |
| Create 1 x 1 Matrix                    | Esc x m   |
| Add Row                                | Esc x r   |
| Add Column                             | Esc x c   |
|  | Control+C |
| Matrix Transpose                       | Esc x t   |
| Matrix Algebra                         | Esc x a   |
| <b>Matrix Row Height pop-up menu</b>   |           |
| Toggle fixed/proportional              | Esc m t r |
| <b>Matrix Column Width pop-up menu</b> |           |
| Toggle fixed/proportional              | Esc m t c |

Table 12-11: Matrices

## Functions

For the functions (except for the general function and the limit) you must have selected an appropriate portion of a formula.

| Element / command           | Short-cut        | Backslash sequence |
|-----------------------------|------------------|--------------------|
| $?(?)$                      | Control+f        | \function          |
| $\lim?$<br>?                | Control+L        | \lim               |
| <b>Addition pop-up menu</b> |                  |                    |
| Add Fractions               | ESC m a a        |                    |
| Order Sum                   | ESC m a o        |                    |
| Order Sum Reverse           | ESC m a O (uc o) |                    |

Table 12-12: Functions on formulas

| Element / command                 | Short-cut                  | Backslash sequence |
|-----------------------------------|----------------------------|--------------------|
| <b>Multiplication pop-up menu</b> |                            |                    |
| Factor                            | ESC m u f                  |                    |
| Factor Some                       | ESC m u F                  |                    |
| Multiply Out                      | ESC m u m                  |                    |
| Multiply Out Once                 | ESC m u M                  |                    |
| Distribute                        | ESC m u d                  |                    |
| Distribute Over Equality          | ESC m u D                  |                    |
| <b>Division pop-up menu</b>       |                            |                    |
| Long Division                     | ESC m d l<br>(lowercase L) |                    |
| Remove Division                   | ESC m d d                  |                    |
| Remove Division 1 Level           | ESC m d D                  |                    |
| Remove Negative Powers            | ESC m d n                  |                    |
| Remove Negative Powers 1 Level    | ESC m d N                  |                    |
| <b>Evaluation pop-up menu</b>     |                            |                    |
| Number Crunch                     | ESC m v n                  |                    |
| Show All Digits                   | ESC m v . (period)         |                    |
| Evaluate                          | ESC m v e                  |                    |
| Evaluate Substitution             | ESC m v s                  |                    |
| Evaluate Integrals                | ESC m v i                  |                    |
| Evaluate Derivatives              | ESC m v d                  |                    |
| Evaluate Derivatives 1 Level      | ESC m v D                  |                    |
| <b>Rules pop-up menu</b>          |                            |                    |
| Enter Rule                        | ESC m r e                  |                    |
| Apply Rule                        | ESC m r a                  |                    |
| Designate Dummy                   | ESC m r d                  |                    |
| <b>Other Rewrites pop-up menu</b> |                            |                    |
| Simplify                          | ESC m o s                  |                    |
| Simplify Some                     | ESC m o S                  |                    |
| Isolate Term                      | ESC m o i                  |                    |
| Expand First Term                 | ESC m o e                  |                    |
| Expand All Terms                  | ESC m o E                  |                    |

Table 12-12: Functions on formulas

## Positioning and line breaking

The number of points shown in the following table is based on a zoom setting of 100 percent.

| Function                                  | Short-cut             |
|---|-----------------------|
| <b>Micro positioning</b>                  |                       |
| Move up 1 point                           | Alt+up arrow          |
| Move down 1 point                         | Alt+down arrow        |
| Move left 1 point                         | Alt+left arrow        |
| Move right 1 point                        | Alt+right arrow       |
| Move up 6 points                          | Alt+Shift+up arrow    |
| Move down 6 points                        | Alt+Shift+down arrow  |
| Move left 6 points                        | Alt+Shift+left arrow  |
| Move right 6 points                       | Alt+Shift+right arrow |
| Remove micro positioning                  | Alt+Home              |
| <b>Left/Right (Alignment) pop-up menu</b> |                       |
| Left                                      | Esc m a l (lc L)      |
| Centre                                    | Esc m a c             |
| Right                                     | Esc m a r             |
| Left of =                                 | Esc m a plus          |
| Command                                   | Shortcut              |
| Right of =                                | Esc m a =             |
| Set Manual                                | Esc m a s             |
| Clear Manual                              | Esc m a d             |
| Reset Alignment                           | Esc m a R             |
| <b>Up/Down (Alignment) pop-up menu</b>    |                       |
| Top                                       | Esc m a t             |
| Baseline                                  | Esc m a B             |
| Bottom                                    | Esc m a b             |
| <b>Line Breaking pop-up menu</b>          |                       |
| Set Manual                                | Esc m b s             |
| Clear Manual                              | Esc m b c             |

Table 12-13: Positioning formula elements

## Navigating in a formula

**Select next prompt** tabs through the entry fields of pop-up dialogues.

| Function                          | Short-cut   |
|-----------------------------------|-------------|
| <b>Moving the insertion point</b> |             |
| Left                              | left arrow  |
| Right                             | right arrow |

Table 12-14: Navigation in a formula

| Function                                | Short-cut   |
|---|-------------|
| From beside a fraction to the numerator | down arrow  |
| <b>Changing the selection</b>           |             |
| <b>Select next prompt</b>               | Tab         |
| Increase scope of selection             | space       |
| Select next element to the left         | left arrow  |
| Select next element to the right        | right arrow |

Table 12-14: Navigation in a formula

## Moving math elements

| Function  | Short-cut                     |
|---|-------------------------------|
| <b>Moving math elements while retaining algebraic equivalency</b>   |                               |
| Left  | Shift+left arrow              |
| Right   | Shift+right arrow             |
| Up  | Shift+up arrow                |
| Down  | Shift+down arrow              |
| To far left   | Control+Alt+left arrow        |
| To far right  | Control+Alt+right arrow       |
| Left into expression  | Control+Shift+left arrow      |
| Right into expression   | Control+Shift+right arrow     |
| <b>Moving math elements without retaining algebraic equivalency</b> |                               |
| Swap with element on left   | Control+m Control+left arrow  |
| Swap with element on right  | Control+m Control+right arrow |

Table 12-15: Moving math elements

# Display comparison

Since Donald Knuth developed T<sub>E</sub>X in the late 1970s for typesetting mathematics the presentation of formulas with this tool is the gauge for

- Relative size of objects (exponents, indices etc.)
- Extension of symbols for root, sum, product etc.
- Extension of parantheses, brackets and braces
- Positioning of attributes (boundaries, limits, etc.)

Keep in mind that *the beauty in the eye of the beholder* [Scottish philosopher David Hume].

I do not have access to many systems, hence the following are mainly copies from books and screenshots.

T<sub>E</sub>X

$$\frac{1}{2\pi} \int_{-\infty}^{\sqrt{y}} \left( \sum_{k=1}^n \sin^2 x_k(t) \right) (f(t) + g(t)) dt$$

$$\left[ \int_1^4 (3x^2 - 2) dx \quad \frac{2}{3} + \frac{1}{6} \quad \sum_{z=1}^5 (z^3 + z) \right] \Bigg|_{y=0}^1$$

FrameMaker

$$\sigma_x = \sqrt{\frac{1}{n} \left\{ \sum_{i=1}^n X_i^2 - \frac{1}{n} \left( \sum_{i=1}^n X_i \right)^2 \right\}} \left[ \int_1^4 (3x^2 - 2) dx \quad \frac{2}{3} + \frac{1}{6} \quad \sum_{z=1}^5 (z^3 + z) \right] \Bigg|_{y=0}^1$$

Mathtype

$$\sigma_x = \sqrt{\frac{1}{n} \left\{ \sum_{i=1}^n X_i^2 - \frac{1}{n} \left( \sum_{i=1}^n X_i \right)^2 \right\}}$$

MS Word EQ Editor 3.0

Object imbedded

Bitmap imbedded

$$\sigma_x = \sqrt{\frac{1}{n} \left\{ \sum_{i=1}^n X_i^2 - \frac{1}{n} \left( \sum_{i=1}^n X_i \right)^2 \right\}} \quad \sigma_x = \sqrt{\frac{1}{n} \left\{ \sum_{i=1}^n X_i^2 - \frac{1}{n} \left( \sum_{i=1}^n X_i \right)^2 \right\}}$$

MathCAD 11

$$\sigma_x := \sqrt{\frac{1}{n} \left[ \sum_{i=1}^n \left[ (x^2)_i \right] - \frac{1}{n} \left( \sum_{i=1}^n x_i \right)^2 \right]}$$

MathML (Netscape 7.1)  
with MIT fonts

$$\int_{x_i}^{x_i+h} f(x) dx \simeq \frac{h(f_i + f_{i+1})}{2} = \frac{1}{2} h f_i + \frac{1}{2} h f_{i+1}$$