Tricks

1. To export a result in the macOS version, click on the result text. The result can now be printed or copied to the pasteboard. (To work properly, it is necessary to click on the result text instead of somewhere else in the result window.)

2. Use `==` to test for equality. In effect, `A==B` is equivalent to `simplify(A-B)==0`.

3. In a script, line breaking is allowed where the scanner needs something to complete an expression. For example, the scanner will automatically go to the next line after an operator.

4. Setting `trace=1` in a script causes each line to be printed just before it is evaluated. Useful for debugging.

5. The last result is stored in symbol `last`.

6. Use `contract(A)` to get the mathematical trace of matrix A.

7. Use `binding(s)` to get the unevaluated binding of symbol s.

8. Use `s=quote(s)` to clear symbol s.

9. Use `float(pi)` to get the floating point value of π. Set `pi=float(pi)` to evaluate expressions with a numerical value for π. Set `pi=quote(pi)` to make π symbolic again.

10. Assign strings to unit names so they are printed normally. For example, setting `meter="meter"` causes symbol `meter` to be printed as meter instead of m_{eter}.

11. Use `expsin` and `expcos` instead of `sin` and `cos`. Trigonometric simplifications occur automatically when exponentials are used. See also `expform` for converting an expression to exponential form.

12. Use `rect(expform(f))` to maybe find a new form of trigonometric expression `f`.

    ```
    f = cos(theta/2)^2
    rect(expform(f))
    ```

    $\frac{1}{2}\cos(\theta)+\frac{1}{2}$

13. Complex number functions `conj`, `mag`, etc. treat undefined symbols as representing real numbers. To define symbols that represent complex numbers, use separate symbols for the real and imaginary parts.

```
z = x + i y
conj(z) z
```

$x^2 + y^2$

```
z = A exp(i theta)
conj(z) z
```

A^2

14. Use `mag` for component magnitude, `abs` for vector magnitude.

```
y = (a, -b)
mag(y)
```

$$\begin{bmatrix} a \\ b \end{bmatrix}$$

```
abs(y)
```

$\left[a^2 + b^2\right]^{1/2}$

15. Use `draw(y[floor(x)],x)` to plot the values of vector `y`.

```
y = (1,2,3,4)
draw(y[floor(x)],x)
```

16. The following exercise[1] demonstrates some `eval` tricks. Let

$$\psi = \frac{\phi_1 + \phi_2}{2} \exp\left(-\frac{iE_1 t}{\hbar}\right) + \frac{\phi_1 - \phi_2}{2} \exp\left(-\frac{iE_2 t}{\hbar}\right)$$

where ϕ_1 and ϕ_2 are orthogonal and operator A has the following eigenvalues.

$$A\phi_1 = a_1\phi_1$$
$$A\phi_2 = a_2\phi_2$$

Verify that

$$\langle A \rangle = \int \psi^* A \psi \, dx = \frac{a_1 + a_2}{2} + \frac{a_1 - a_2}{2} \cos\left(\frac{(E_1 - E_2)t}{\hbar}\right)$$

Note: Because ϕ_1 and ϕ_2 are normalized we have $\int |\phi_1|^2 = \int |\phi_2|^2 = 1$. By orthogonality we have $\int \phi_1^* \phi_2 = 0$. Hence the integral can be accomplished with `eval`.

```
psi = (phi1 + phi2) / 2 exp(-i E1 t / hbar) +
      (phi1 - phi2) / 2 exp(-i E2 t / hbar)

Apsi = eval(psi, phi1, a1 phi1, phi2, a2 phi2) -- eigenvalues

phi1 = r1 exp(i theta1)
phi2 = r2 exp(i theta2)

A = conj(psi) Apsi

A = eval(A, r1^2, 1, r2^2, 1, r1 r2, 0) -- integral

A == (a1 + a2) / 2 + (a1 - a2) / 2 cos((E1 - E2) t / hbar)
```

[1] See exercise 4-10 of *Quantum Mechanics* by Richard Fitzpatrick.