Maple 11 Cheat Sheet

Syntax

; Ends a command with a semicolon. e.g. 5+6; plot(x);

= Assigns an expression to a variable. e.g. a:=3; b:=a+x;

:= Defines mathematical equations. e.g. y = x^2 + 3*x + 4;

% Refers to the last result. e.g. %%% gives the third previous result.

L Refers to the last result. e.g. L := [1, 2, ...]; L[] refers to the first item of the list.

f:=(x,y,...)->... Defines a function. e.g. f := (x,y) -> x^2+y^2; defines the function f(x,y) = x^2 + y^2. f(0,1) evaluates f(0,1) = 0^2 + 1^2 = 1.

L:=[x1, x2, ..., xn] Defines a list (ordered sequence) L of expressions x1, x2, ..., xn. Refer to the nth list item by L[n]. To extract the contents of a list, use the empty selection operator[]. e.g. A:=[1,2,3]; A[3]; returns 3. A[] returns 1,2,3.

S:={x1, x2, ..., xn} Defines a set S of expressions x1, x2, ..., xn. Use the empty selection operator[] to extract the contents of a set. e.g. S:={5,3,3,2,1}; S[]; returns 1,3,4,5.

?topic Displays help on topic.

All identifiers (variables and functions) are case sensitive. e.g. X is different from x. Pi and pi are different!

In general, a function whose name begins with a capital letter is an inert form of the function who has the same name but begins with lower case. Inert functions are unevaluated and may be manipulated and printed in a prettyprinted format. e.g. Int(x,x); returns \( \int x \, dx \) and is the inert form of \( \int (x,x) \);, which evaluates to \( x^2/2 \).

Usages

Right-click an expression to display a context-sensitive menu of applicable options.

!!! Click the !!! icon to execute the entire worksheet. Useful when you have changed expressions that affect subsequent commands.
Algebra

simplify(expression); Applies simplification rules to the given expression. e.g. simplify(cos(Pi*cos(x)^2+Pi*sin(x)^2)); returns -1.

collect(expression, variable); Combines like terms in expression with respect to the given variable. e.g. collect(a^2*x+b*x+5, x); returns 5 + (a^2 + b)x.

normal(expression); Simplifies and normalizes the given rational expression so that the result is of factored normal form, where the numerator and denominator are relatively prime polynomials with integer coefficients. e.g. normal(1/x+x/(x+1)); returns \(\frac{x^2 + 3}{x+1}\).

factor(expression); Factors the given expression of a multivariate polynomial. Does NOT factor integers or integer coefficients in a polynomial. e.g. factor(4*x^2+12*x+8) returns 4(x + 1)(x + 2).

ifactor(expression); Factors an integer or rational number into a product of primes. e.g. ifactor(24/19); returns \(\frac{2^2\cdot3}{19}\). ifactor(2*10-1); returns (3)(11)(31).

expand(expression); Distributes the given expression. e.g. expand((x+3)*(x+5)); returns \(x^2 + 8x + 15\).

solve(equations, variables); Solves for the unknown variables in the given equations or inequalities.

e.g. solve(x^2-25=0, x); solves the equation \(x^2 - 25 = 0\) and returns 5,-5.

e.g. solve({x+y+z = 6, x-y+2*z = 5, 2*x+2*y+z = 9}, {x, y, z}) solves the system of three equations and returns the solution \([x = 1, y = 2, z = 3]\).

e.g. solve(abs(x+5) > 3, x); solves the inequality \(|x+5| > 3\) and returns RealRange(Open(-2), infinity), RealRange(-infinity, Open(-8)).

Calculus

diff(f, x1, ..., xj); Differentiates \(f\) with respect to variables \(x_1, ..., x_j\). e.g. diff(sin(x), x); takes the first derivative of \(sin(x)\). diff(f(x,y),x,y); computes \(\frac{\partial^2 f}{\partial y \partial x}\)(f(x,y)).

diff(f, x$n$); Computes the \(n^{th}\) derivative of \(f\). e.g. diff(x^4, x$2$); computes the second derivative of \(x^4\) and returns 12\(x^2\).

int(f, z); Computes an indefinite integral of \(f\) with respect to the variable \(x\). e.g. int(cos(x), x); computes \(\int cos(x)dx\) and returns \(sin(x)\).

int(f, x=a..b); Computes the definite integral of \(f\) with respect to the variable \(x\) on the interval from \(a\) to \(b\). e.g. int(x$^2$, x=0..2); computes \(\int_0^2 x^2 dx\) and returns 8/3.

limit(f, x=a, [dir]); Computes the limit of \(f\) as \(x\) approaches \(a\). \(a\) can be any algebraic expression or infinity. Direction \(dir\) is optional and is real bidirectional by default (except for \(\infty\) and \(-\infty\)). Possible values of direction are left, right, real, and complex. e.g. limit(1/exp(x), x=infinity); computes \(\lim_{x \to \infty} \frac{1}{e^x}\) and returns 0.

sum(f, k=m..n); Returns the summation \(\sum_{k=m}^{n} f(k)\). e.g. sum(x^2, x=1..n); computes \(\sum_{x=1}^{n} x^2\).
Plots

plot(f, x=xmin..xmax, options); Creates a two-dimensional plot of the real function \( f(x) \) over the horizontal range from \( xmin \) to \( xmax \). Options are specified in the form option=value (see box below).

- \( f \) is a function with an independent variable. e.g. plot(x^2, x=-5..5);
- \( f \) is represented parametrically: \([x(t), y(t), t=t_0..t_1]\). e.g. plot([cos(t), sin(t), t=-2*Pi..2*Pi]);
- \( f \) is a list of functions to be graphed on the same plot: \([f1, f2, ..., fn]\). e.g. plot([1,x,x^2], x=a..b, options);

implicitplot(eqn, x=xmin..xmax, y=ymin..ymax, options); In the plots package. i.e. Must be preceded by with(plots); Creates the two-dimensional plot of an implicitly defined curve \( eqn \) over the specified intervals: \([xmin, xmax]\) and \([ymin, ymax]\). Options are specified in the form option=value (see box below).

inequal(ineqs, x=xmin..xmax, y=ymin..ymax, options); In the plots package. Plots regions defined by inequalities \( ineqs \) in the specified \( x \) and \( y \) intervals. Options are in the form optionsfeasible / optionsopen / optionsclosed / optionsexcluded = (optionslist), where optionslist is of the format \((option=value, option2=value2, ...). e.g. inequal(x+y>0, x-y<1, x=-3..3, y=-3..3, optionsexcluded=(color=blue, thickness=2));

options for Plot, Implicitplot, and Inequal

- Type of axes axes=boxed/frame/none/normal
- Color of curves color=blue/black/green/red/etc.
- Determine input discontinuities discont=true/false
- Draw gridlines gridlines=true/false
- Label Axes labels=[x,y]
- Scaling scaling=constrained/unconstrained
- Line thickness thickness=number
- Title title="plot title"
- Min/max y values y=ymin..ymax
- View window view=[xmin..xmax, ymin..ymax]

plot3d(f, x=a..b, y=c..d, options); Creates a three-dimensional plot of the real function \( f(x, y) \) over the horizontal range \([a, b]\) and vertical range \([c, d]\). Options are specified in the form option=value (see box below).

- \( f \) is a function with two independent variables. e.g. plot(sin(x+y), x=-1..1, y=-1..1);
- \( f \) is represented parametrically: \([f1(x,y), f2(x,y), f3(x,y)]\). e.g. plot3d([x*sin(x)*cos(y), x*cos(x)*cos(y), x*sin(y)], x=0..2*Pi, y=0..Pi);
- \( f \) is a list of functions to be graphed on the same plot: \([f1(x,y), f2(x,y), ..., fn(x,y)]\). If there are three functions, use the plotlist option to avoid a parametric plot. e.g. plot3d([sin(x*y), cos(x*y), x*y], x=-1..1, y=-1..1, plotlist); puts the functions \( z = \sin(xy), z = \cos(xy), \) and \( z = x + y \) on the same plot.

implicitplot3d(eqn, x=min..max, y=min..max, z=min..max, options); In the plots package. Creates the three-dimensional plot of an implicitly defined surface \( eqn \) on the specified intervals: \([xmin, xmax]\) and \([ymin, ymax]\) and \([zmin, zmax]\). Options are specified in the form option=value (see box below).

animate(plotcommand, plotargs, t=a..b, options); In the plots package. Creates a 2-D or 3-D animation on parameter \( t \), ranging from \( a \) to \( b \). \( plotcommand \) is a Maple command that generates a 2-D or 3-D plot (e.g. plot, plot3d, implicitplot). \( plotargs \) is a list of arguments to the plot command. Possible options are those used in the plot command or the following:

- Number of frames frames=n
- Display a trace of \( n \) frames trace=n
- Display L options; In the plots package. Combines the list \( L \) of plot structures into a single plot or animation. \( options \) are those used for plot or plot3d.

animate(plot(sin(x), x=0..10), A=0..2, frames=50, trace=5);