Mathematica quick reference

Items marked with ▶ should be mastered within the first two weeks of the semester.

▶Arithmetic

Syntax	Read As	Example
`-,+,*,/`	subtraction, addition, multiplication, division	`2*x-4/x`
space	multiplication	`k x` is the same as `k*x`
$\wedge$	exponentiation	`2^3`

Common error: forgetting the space in multiplication: `kx` does not equal `k` times `x`.

▶Brackets

Syntax	Read As	Use	Example
`[ ]`	square brackets	enclosing arguments of functions	`Sin[2.5]`
`( )`	parentheses	grouping terms algebraically	`(3x-x^3)^(7/2)`
`{ }`	curly braces	lists, ordered pairs	`Plot[f[x],{x,0,2}]`

Common errors: missing parentheses in algebra: `x/2+x` is not the same as `x/(2+x)`
using parentheses for functions

▶Built-in Functions

Function	Syntax	Function	Syntax	Function	Syntax
$\sin(x)$	`Sin[x]`	$\cos(x)$	`Cos[x]`	$\tan(x)$	`Tan[x]`
$\arcsin(x)$	`ArcSin[x]`	$\arccos(x)$	`ArcCos[x]`	$\arctan(x)$	`ArcTan[x]`
$\ln(x)$	`Log[x]`	$\log_a(x)$	`Log[a,x]`	e^x	`Exp[x], E^x`
$\sqrt{x}$	`Sqrt[x], x^(1/2)`	$n!$	`n!`	$\sqrt[3]{x}$	`CubeRoot[x]`
$\sqrt[n]{(-x)}$	`Surd[-x,n]`			$x^{3/5}$	`Surd[x^3,5]`

Common errors: capitalization. *Mathematica* is picky! All built-in functions begin with a capital letter.
using exponentiation (e.g. $x^{3/5}$) for nth roots of negative numbers

▶Built-in Constants and Symbols

Constant	π	e	i	∞
Syntax	`Pi`, `ESC p ESC`	`E`	`I`	`Infinity`, `ESC inf ESC`

Common error: using `e` instead of `E`, using `I` for ∞

Keyboard Shortcuts

Raised exponents	use `Ctrl+^` (or `Ctrl+6`)
Stacked fractions	use `Ctrl+/`
Radical ($\sqrt{\ }$)	use `Ctrl+2`
List commands	type the first three letters and `Cmd+k` (Mac) or `Ctrl+k` (PC)
Make Template	type full command name `Cmd+Shift+k` (Mac) or `Ctrl+Shift+k` (PC)

Symbolic vs Numeric output

Mathematica works symbolically (algebraically) and gives exact answers unless instructed otherwise. Use a decimal in a number (eg, `Pi/3.0` instead of `Pi/3`) or the `N[ ]` command to get a decimal expansion. Use `N[expr,n]` or `SetPrecision[expr,n]`to display n significant digits.

Getting help

Use `?CommandName` or the Documentation Center to get more information on specific commands.

▶Equal Signs

Syntax	Read As	Use	Example
`=`	set equal to	defining variables and some functions	`a=3.2`
`:=`	set delayed	defining functions	`f[x_]:=3x-7`
`==`	equal	equations	`Solve[x^2==3,x]`

▶Solving Equations

Syntax	Use	Example
`Solve[ ]`	solves equation(s) exactly using algebra	`Solve[{x==3y-2,x^2+y^4==3},{x,y}]`
`NSolve[ ]`	decimal expansion of algebraic solution	`NSolve[{x==3y-2,x^2+y^4==3},{x,y}]`
`FindRoot[ ]`	numerically approximates ONE solution returns solution near $x = x_0$	`FindRoot[x^2==3Sin[x],{x,x0}]`

Common errors: Using `=` instead of `==`. May need to use `Clear[ ]` to recover.
Warning: Some versions of *Mathematica* will reformat `==` as $=\!=$, making this error hard to identify.
Entering an interval instead of a single initial guess in `FindRoot[ ]`.

▶Defining Your Own Functions

You tell Mathematica which variables are the independent variables using an underscore. Use `:=` instead of `=` to enable syntactic color-coding.

`f[x_]:=Sin[x^2+7x]+Cos[x]`

`g[x_,t_]:=E^x Sin[t]`

Plotting and Plot Options

Plot type	Syntax
▶ plot $f(x)$ on interval $[a, b]$	`Plot[f[x],{x,a,b}]`
▶ plot $f(x)$ and $g(x)$ together	`Plot[{f[x],g[x]},{x,a,b}]`
Implicit plot of $f(x, y) = 0$ in $\mathbb{R}^2$ over $a \le x \le b$ and $c \le y \le d$	`ContourPlot[f[x,y]==0,{x,a,b},{y,c,d}]`
Parametric plot of $x = x(t), y = y(t)$ with $a \le t \le b$	`ParametricPlot[{x[t],y[t]},{t,a,b}]`
plotting list of data points	`ListPlot[{{1,2},{2,3},{3,6}},Joined->True]`
Plotting in $\mathbb{R}^3$	`Plot3D[ ]`, `ParametricPlot3D[ ]`, `ContourPlot3D[ ]`
Plot $f(x)$ with thick curve	`Plot[f[x],{x,-2,5},PlotStyle->Thick]`
Plot f with displayed y-range to $3 \le y \le 7$	`Plot[f[x],{x,-2,5},PlotRange->{{-2,5},{3,7}}]`
shade between curve and axis	`Plot[f[x],{x,-2,5},Filling->Axis]`
shade between two curves	`Plot[{f[x],g[x]},{x,-2,5},Filling->{1}]`

Working with Functions

Mathematical Operation	usual notation	Syntax
evaluate a function	$f(3)$	`f[3]`
differentiate	$\frac{d}{dx}f(x)$ or $f'(x)$	`D[f[x],x]` or `f'[x]`
indefinite integral	$\int f(x)\,dx$	`Integrate[f[x],x]`
definite integral (exact)	$\int_a^b f(x)\,dx$	`Integrate[f[x],{x,a,b}]`
definite integral (approx)	$\int_a^b f(x)\,dx$	`NIntegrate[f[x],{x,a,b}]`

Other Useful Commands

Syntax	Use	Example
`Simplify[ ]`	attempts to simplify expression	`Simplify[x(2-x)-3x+1]`
`Factor[ ]`	attempts to factor expression	`Factor[x^3+3x^2+3x+1]`
`Expand[ ]`	multiplies out (expands)	`Expand[(x-7)(x^2-11x-1)^3]`
`Apart[ ]`	partial fraction decomposition of $\frac{f(x)}{g(x)}$	`Apart[(3x-2)(x^2-1)]`
`Eliminate[ ]`	eliminate a variable from set of equations	`Eliminate[{x==t^2+1,y==5/t},t]`
`Reduce[ ]`	symbolically solves equations giving conditions	`Reduce[{x+Cos[x*y]==0},{x,y}]`