

# desmos

## User Guide

Learn more about graphing functions, plotting tables of data, evaluating equations, exploring transformations, and more! If you have questions that aren't answered in here, send us an email at [calculator@desmos.com](mailto:calculator@desmos.com).

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# Getting Started with Desmos

## Making a graph

Welcome to Desmos!! To create a new graph, just type your expression in the expression list bar. As you are typing your expression, the calculator will immediately draw your graph on the graph paper.

### Open Graph

Revisit your saved graphs and example graphs here.

### Save As or Rename

Click here to save a copy of your graph or rename it. You can also press `ctrl+shift+s`.

### Save

Click here to save your graph or press `ctrl+s`.

### Add Item

Add a new expression, table, text box, folder, or image.

### Hide

Click here to hide individual expressions. Long-hold to change the color or style.

### Delete all

Delete all of your expressions here.

### Change color

Choose a new color for the expression.

### Undo and Redo

You can also press `ctrl+z` to undo and `ctrl+y` to redo.

### Edit List

Delete, duplicate, change color, or convert to table.

### Delete

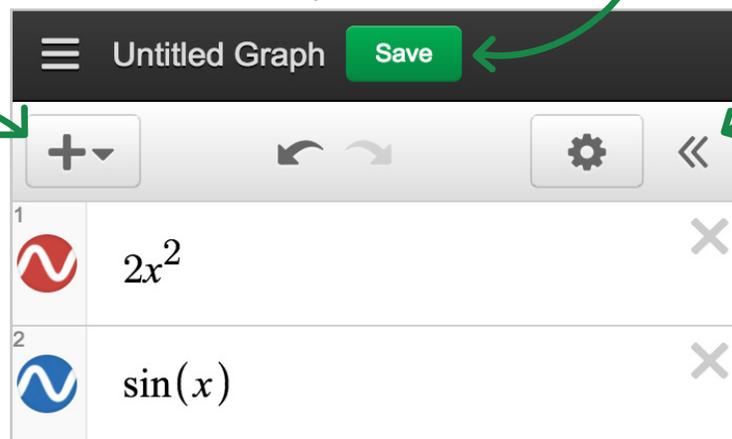
Click here to remove your expression.

### Convert to table

Generate a table from the expression.

### Duplicate

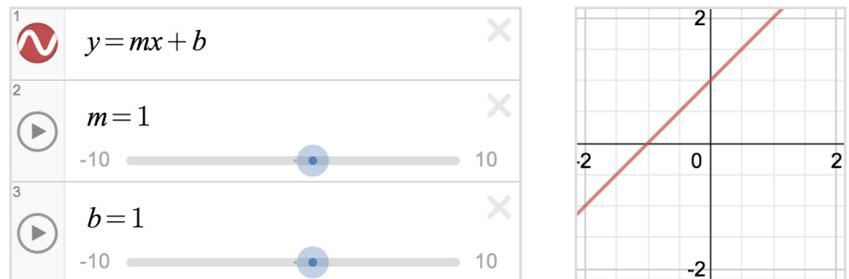
Add a copy of the expression below the current one.



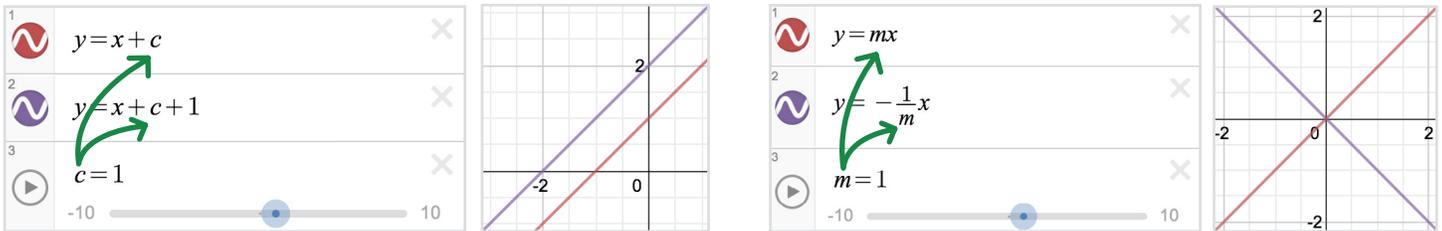
# Variables and Sliders

You can graph a single line by entering an expression like  $y = 2x + 3$ . To make the graph more dynamic, you can use parameters instead of constants: for example,  $y = mx + b$ . Add sliders for the undefined parameters by clicking the prompt or define the parameters yourself by entering  $m=2$  and  $b=3$ . When you give constant values to parameters like  $m$  and  $b$ , the calculator will automatically allow you to adjust their values with sliders. Adjusting  $m$  with the slider changes the slope of the line, and adjusting  $b$  with the slider changes the intercept.

Any time you have free variables in an expression, the calculator will offer to let you define them with sliders:

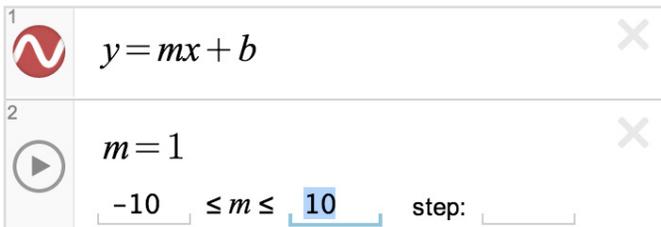


You can use the same variables in several expressions to plot curves that will change together. For example:



The value of  $c$  defines two parallel lines that move up and down together.

These two lines stay perpendicular to each other for any value of  $m$ .



To adjust the limits and interval of your slider, click either of the values at the ends of the slider bar. Input your desired values and click the expression or the graph to complete the adjustment.

To create a movable point, enter a point with a variable for at least one coordinate. Click and drag the point around the graph to change the value of the parameter(s). To make graphs more interactive, use parameters from your movable point in your expressions. For example, you can graph the line  $y - b = m(x - a)$  and plot the movable point  $(a, b)$  to see the line move when you drag the point - don't forget to add sliders!

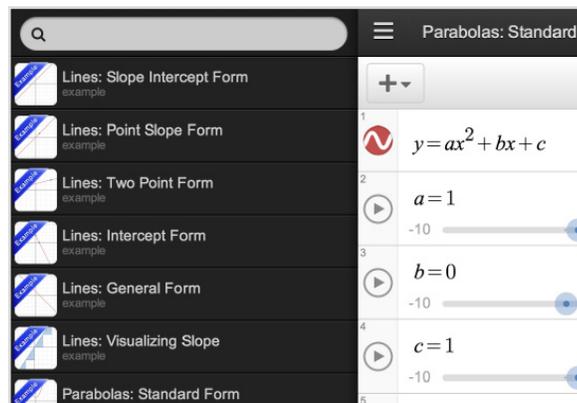


## Saving a graph

You will need to be signed in to save and open your graphs.

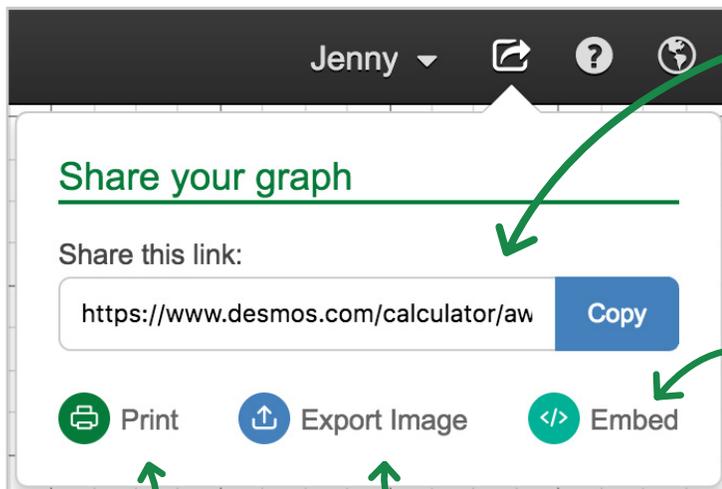
Save a graph by pressing the save button located to the right of the title bar or pressing  $\text{ctrl} + \text{s}$  on your keyboard.

Access your saved graphs by clicking the my graphs icon:



## Sharing a graph

Clicking in the top toolbar will allow you to share your graphs.



### Permalink

Underneath the social sharing options, you will see a permalink for your graph. You can copy this link and share it with anyone. When they open it, they will see your graph and all of the equations.

### Embed

Copy the HTML embed code to post your graph in a website or wiki.

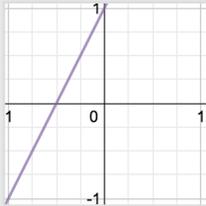
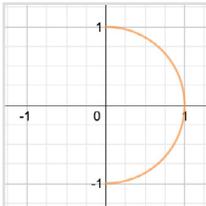
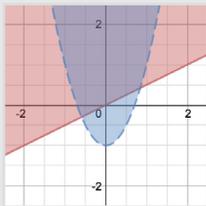
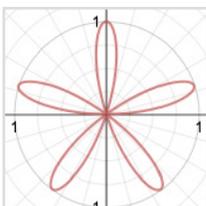
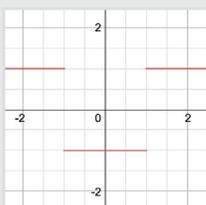
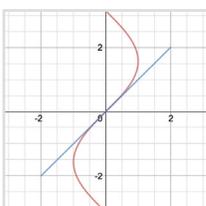
### Print

Use this link to print your graph and equations.

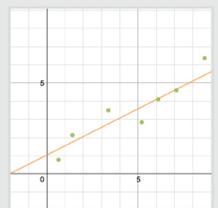
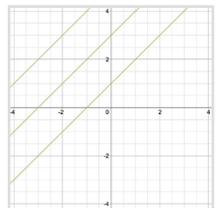
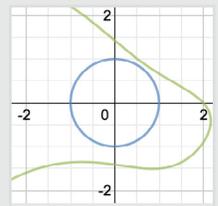
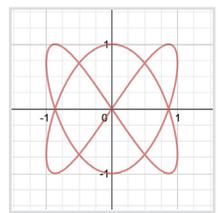
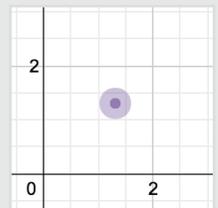
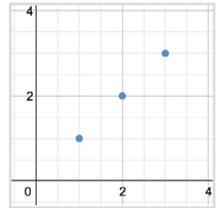
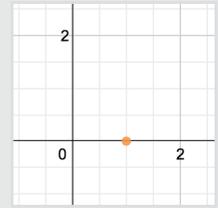
### Export Image

Grab an image of your graph by clicking the Export Image link. You can customize thickness and size before exporting.

# Graphable Expressions

Type of Graph	Example	Notes
Regular function	$y=2x+1$	
x in terms of y	$x=\sqrt{1-y^2}$	
Inequalities	$x \leq 2y$ $2x^2 - 1 < y < 4$	Strict inequalities are plotted with dashed lines 
Polar	$r=\sin(5\theta)$	Expressions with r and theta ( $\theta$ ) will be interpreted as polar 
Piecewise	$y=\{-1 < x < 1 : -1, 1\}$	Use the {condition: value, default} format for piecewise functions. 
Domain and range restrictions	$y=x\{-2 < x < 2\}$ $x=\sin(y)\{-\pi < y < \pi\}$	Add the restriction at the end of the equation. Try the restrictions tour in the help menu. 

Type of Graph	Example	Notes
Point	$(1,0)$	Use parentheses to plot points
Point List	$(1,1), (2,2), (3,3)$	You can plot several points by separating them with commas
Movable Point	$(a,b)$	Use a parameter for at least one coordinate
Parametric	$(\sin(2t), \cos(3t))$	Parametric equations have the same form as points. Any point with functions of $t$ for coordinates will be plotted as a parametric equation
Implicit	$x^2 + y^2 = 1$ $y^2 + \sin(x)y + x = 2$	Solutions of equations involving $x$ and $y$ can be plotted without solving for $x$ or $y$
List Expressions	$y = x + [1,3,5]$	Learn more about lists on page 8.
Regression	$y_1 \sim mx_1 + b$	Learn more about regressions on page 9.



# Settings, Zoom, and Language

## Settings

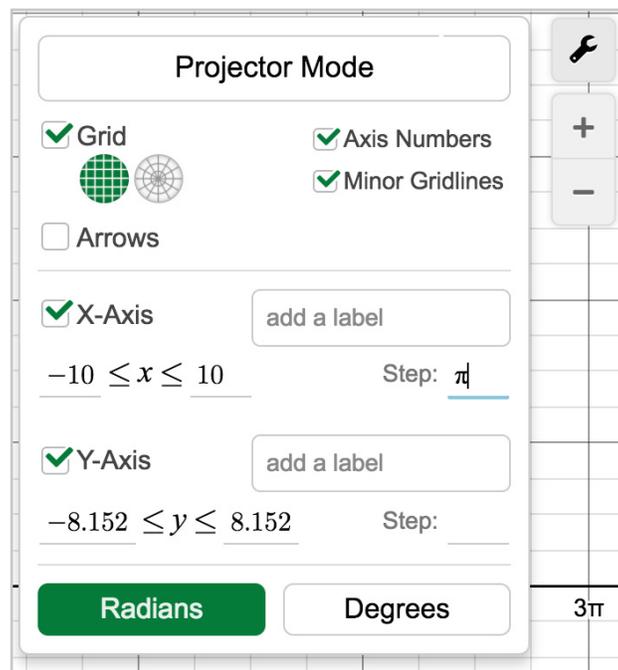
### Projector Mode

Using projector mode will make the graph and axes lines thicker, and the number labels larger. This is great for students sitting in the back of the classroom who are looking at Desmos on the projector.

### Graph Paper

In the graph paper section you can change the grid and axes. Click the green circular icons to choose between Cartesian and Polar grids and show or hide axes and labels.

Click the gray arrow next to an axis to adjust the window size, add a step (try “pi”), or add arrows.



### Angles

Choose between radians and degrees here.

## Zoom

You may zoom in and out of the calculator by using the zoom buttons in the zoom menu. If your axes are no longer square, click the square option. To return to the default view, click the default option.

### Other ways to zoom:

If you are using a touch-enabled device, you may also use the pinch and zoom technique within the graphing space. While using a computer with a mouse, you can use the scroll wheel for zooming. Click and drag within the graphing window to pan your graph within the graphing space.



## Language

To change the language of the calculator interface, click the  icon and select your language from the list. If you don't see your language and would like to help with translation, email us at [translations@desmos.com](mailto:translations@desmos.com).

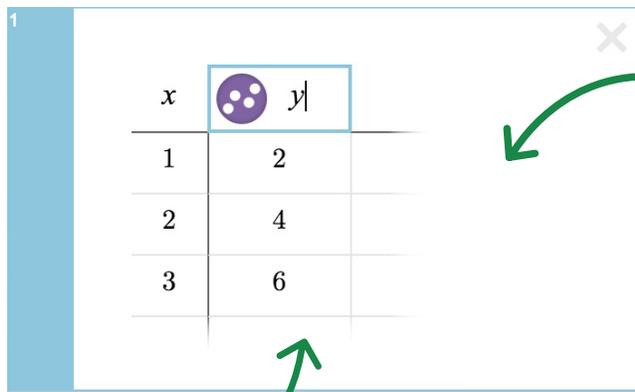
# Tables

Dive deeper into data with tables! You can create a new table or convert an existing expression into a table. You can even copy/paste two column data from a spreadsheet into an empty expression box to quickly create a new table.



## Add Table

Click the "Add Item" button to create a new table.

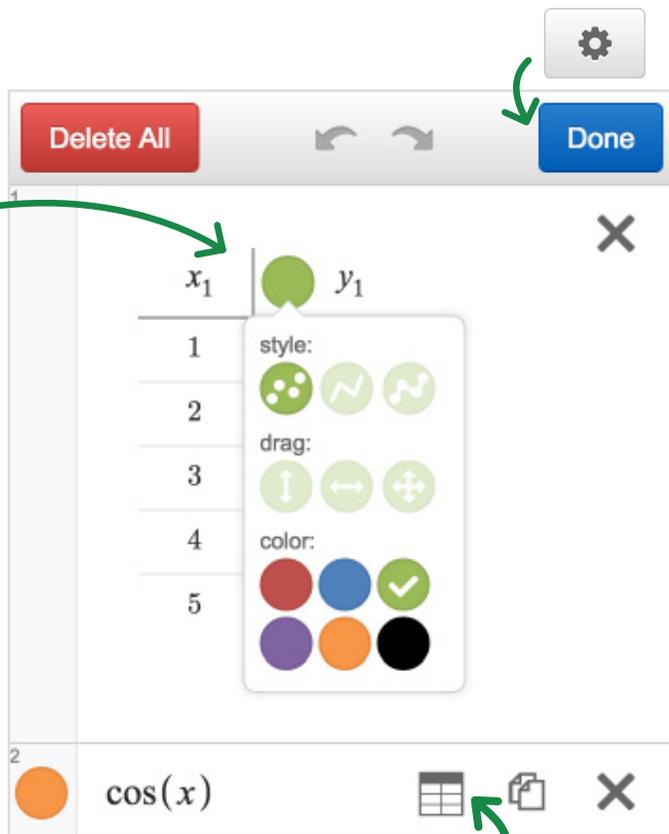


## Add Column

Make a new column by hitting the right arrow key or clicking in the top cell of the column.

## Add Row

Make a new row by hitting the down arrow key or clicking in the cell.



## Options Menu

Click the icon to change color, connect or hide the points, or insert a new column.

In edit mode, click the "convert to table" icon to create a table from your expression.

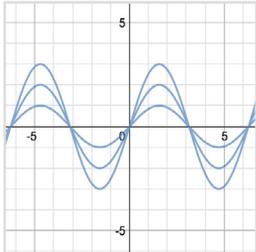
# Lists and Statistics

You can make lists in Desmos using square brackets like this:  $[1,1,2,3,5,8]$

You can create lists with evenly spaced elements.  $[1,\dots,10]$  is a list of the integers between 1 and 10.  $[1,3,\dots,11]$  is a list of the odd integers between 1 and 11.

1  $a = [1,2,3]$

2   $y = a \cdot \sin(x)$



You can use lists anywhere in expressions that you would use a number.

1  $\text{mean}([1,2,3,4])$  = 2.5

2  $\text{length}([1,1,1,1])$  = 4

Statistics functions like mean, median, min, max, and stdev take a list as an argument and return a number.

1

$x_1$	$y_1$
1.7	10.4
3	12.1
4.7	13.7
6	15
7.5	16.3

2  $\text{min}(x_1)$  = 1.7

3  $\text{total}(y_1)$  = 67.5

Table columns are available as lists in the rest of the system.

# Regressions

$\sim$  is our magic regression symbol. Basically, if you connect two lists of data with a  $\sim$ , we adjust every free parameter to make the lists as close to each other as possible.

Since table columns are each lists, the easiest way to make a regression is to create a new table of data, and then write an equation like  $y_1 \sim mx_1 + b$ . Here, we'll adjust  $m$  &  $b$  to find the best linear model. If you instead type  $y_1 \sim ax_1^2 + bx_1 + c$ , we'll find the best quadratic fit.

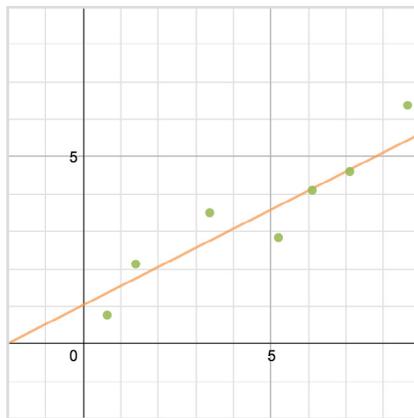
1

$y_1 \sim mx_1 + b$

<p>STATISTICS</p> <p><math>r^2 = 0.932</math></p> <p><math>r = 0.965</math></p> <p>PARAMETERS</p> <p><math>m = 0.50942</math></p>	<p>RESIDUALS</p> <p><math>e_1</math> <input type="button" value="plot"/></p> <p><math>b = 1.0346</math></p>
---	---

2

$x_1$	$y_1$
0.64	0.77
1.4	2.13
3.37	3.5
5.2	2.84
6.1	4.1



If  $x_1$  and  $y_1$  are table columns, then  $y_1 \sim mx_1 + b$  is a regression that finds the least squares values of  $m$  and  $b$  and plots the best fit line.

You can click  to plot residuals, or use residuals in other expressions. For example  $\text{mean}(e_1^2)$  is the mean of the squares of the residuals.

Jenny ▾

**Tours**

Sliders

Tables

Restrictions

Regressions

Try the regressions tour in the help menu for a guided introduction to creating regressions in the calculator.

# Notes, Folders, and Images



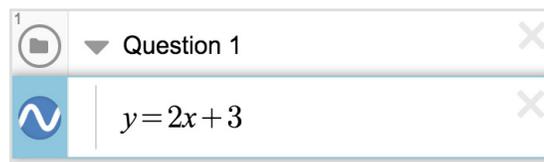
In addition to expressions and tables, you can add helpful non-math items to your expression list.

## Note

Add a note from the expression drop down, or by pressing the quote key “ in an empty expression box.

## Folder

Folders allow grouping expressions, collapsing groups, and showing/hiding a whole group at once.

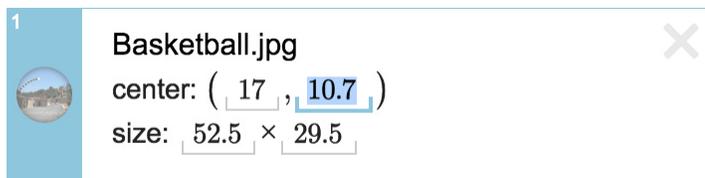


You can drag equations into the folder - a gray line will show up to the left of the equation to let you know it's in the folder. You can click the

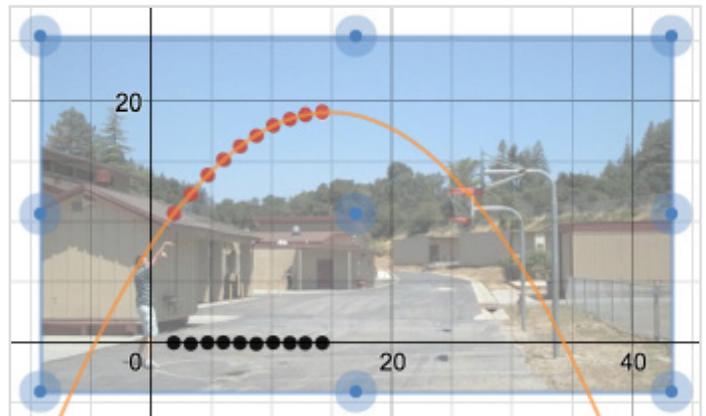
arrow next to the folder name to expand/collapse the folder contents and clicking the folder icon will show/hide the contents.

## Image

Add an image from the drop down, or drag your image into the expression list.



You can edit image position and size by manually setting it in the expression list or dragging the blue points on the graph paper.



Amazing photo by Dan Meyer

# Supported Functions

## Exponents & Logs

$\exp(x)$

$\ln(x)$

$\log(x)$

$\log_n(x)$

$x^n$

$\sqrt{x}$

## Precalc & Calculus

$d/dx$

$\Sigma$

$\Pi$

## Misc

$\text{lcm}(a, b)$

$\text{gcd}(a, b)$

$\text{mod}(a, b)$

$\text{ceil}(x)$

$\text{floor}(x)$

$\text{round}(x)$

$\text{abs}(x)$

$\text{sign}(x)$

## Stats & Probability

$\text{total}(x_1)$

*sum of all elements in a list*

$\text{length}(x_1)$

*number of elements in a list*

$\text{mean}(x_1)$

$\text{median}(x_1)$

$\text{min}(x_1)$

$\text{max}(x_1)$

$\text{quantile}(x_1, p)$

$\text{mad}(x_1)$

*mean absolute deviation*

$\text{stdev}(x_1)$

*sample standard deviation*

$\text{stdevp}(x_1)$

*population standard deviation*

$\text{var}(x_1)$

*variance*

$\text{cov}(x_1, x_2)$

*covariance*

$\text{corr}(x_1, x_2)$

*pearson correlation coefficient of two lists*

$nCr(n, r)$

*number of combinations*

$nPr(n, r)$

*number of permutations*

$n!$

*factorial*

## Trig Functions

$\sin(x)$     $\arcsin(x)$     $\sinh(x)$

$\cos(x)$     $\arccos(x)$     $\cosh(x)$

$\tan(x)$     $\arctan(x)$     $\tanh(x)$

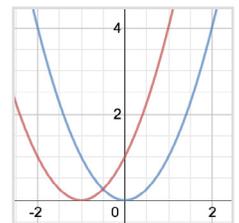
$\sec(x)$     $\text{arcsec}(x)$     $\text{sech}(x)$

$\csc(x)$     $\text{arccsc}(x)$     $\text{csch}(x)$

$\cot(x)$     $\text{arccot}(x)$     $\text{coth}(x)$

## Define your own function

You can also create your own functions, which can be defined with any letter (except for the special ones, like  $x, y, r, t,$  and  $e$ ). Your custom functions can then be used like any other function on this list. For example, if you type  $f(x) = x^2$ , you can then graph  $y = f(x+1)$ , which is the same parabola but shifted over to the left:



# Keyboard Shortcuts

View all of the keyboard shortcuts by clicking the “keyboard shortcuts” link in the help menu.

Open Graph: ctrl + o

Save: ctrl + s

Save-As or Rename: ctrl + shift + s

Undo: ctrl + z

Redo: ctrl + y

New expression: Press “enter”

Move up/down: Press the ↑ and ↓ arrow keys

Move left/right: Press the ← and → arrow keys

Add a new text box: Press the quotation keys (“ ”)

Delete an expression: Press “delete”

## Symbols

$\Sigma$  : Type “sum”

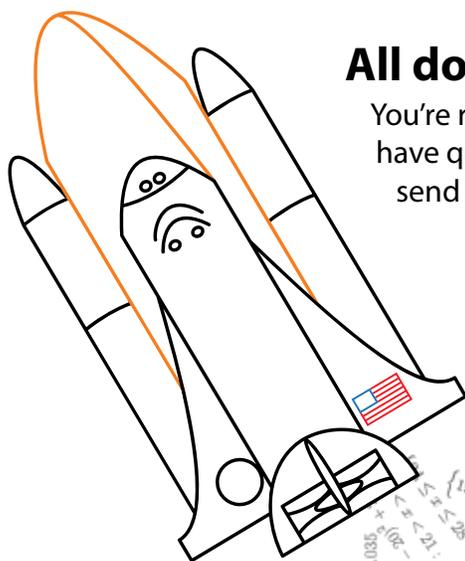
$\pi$  : Type “pi”

$\theta$  : Type “theta”

$\sqrt{\quad}$  : Type “sqrt”

*Type “nthroot” for cubed roots, etc*

$\prod$  : Type “prod”



## All done!

You're ready to take off and explore Desmos! If you have questions that we didn't answer in here, send us an email at [calculator@desmos.com](mailto:calculator@desmos.com).