

## Patterns Screen

In the Patterns screen, students explore a variety of functions, make predictions, compose functions, and define a function.

**DRAG** inputs through the function builder

**SEE INSIDE** the function; **DRAG** a card past each function and watch it transform

**COMPOSE** more than one function

**DRAG** outputs backward through the function. If a function is non-invertible, get feedback:

Function Builder

Patterns Numbers Equations Mystery

## Number Screen

In the Numbers screen, students can interpret arithmetic functions and compare multiple representations.

**VIEW** your input/output pairs in a table

**BUILD** your function with inputs ranging from [-4,7]

**VIEW** your function as an equation

**SHOW** all operations or simplify

Input	Output
-1	$\frac{1}{2}$
0	1
1	$\frac{3}{2}$

Output =  $\frac{\text{Input} + 2}{2}$

Function Builder

Patterns Numbers Equations Mystery

## Equations Screen

In the Equations screen, students can build, interpret, compare, and translate between multiple representations of an algebraic function.

**VIEW** your input/output pairs in a table

**DRAG** x to see all possible points on the graph

**VIEW** your input/output pairs in a graph

**CHANGE** your function at any time

**VIEW** your function as an equation

Function Builder

Patterns Numbers Equations Mystery

PhET

## Complex Controls

- The carousel contains inputs ranging from  $[-4, 6]$  and  $x$ .
- Slope-intercept form is always shown on the  $x$  card as it advances through the function and when it is in the output carousel.

## Mystery Screen

In the Mystery screen, students can play detective to determine the hidden functions.

**REVEAL** the mystery functions after creating at least three input/output pairs

**SEE INSIDE** the function after creating at least two input/output pairs

**REFRESH** to get a random challenge

**RESET** to get the original three challenges

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## Customization Options

Query parameters allow for customization of the simulation, and can be added by appending a '?' to the sim URL, and separating each query parameter with a '&'. The general URL pattern is:

```
...html?queryParameter1&queryParameter2&queryParameter3
```

For example, in Function Builder, if you only want to include the 1st and 2nd screens (`screens=1, 2`), with the 2nd screen open by default (`initialScreen=2`) use:  
[https://phet.colorado.edu/sims/html/function-builder/latest/function-builder\\_all.html?screens=1,2&initialScreen=2](https://phet.colorado.edu/sims/html/function-builder/latest/function-builder_all.html?screens=1,2&initialScreen=2)

To run this in Spanish (`locale=es`), the URL would become:  
[https://phet.colorado.edu/sims/html/function-builder/latest/function-builder\\_all.html?locale=es&screens=1,2&initialScreen=2](https://phet.colorado.edu/sims/html/function-builder/latest/function-builder_all.html?locale=es&screens=1,2&initialScreen=2)

Query Parameter and Description	Example Links
<code>screens</code> - specifies which screens are included in the sim and their order. Each screen should be separated by a comma. For more information, visit the <a href="#">Help Center</a> .	<code>screens=1</code> <code>screens=2, 1</code>
<code>initialScreen</code> - opens the sim directly to the specified screen, bypassing the home screen.	<code>initialScreen=1</code> <code>initialScreen=3</code>
<code>locale</code> - specify the language of the simulation using <a href="#">ISO 639-1</a> codes. Available locales can be found on the simulation page on the <a href="#">Translations tab</a> . Note: this only works if the simulation URL ends in “_all.html”.	<code>locale=es</code> (Spanish) <code>locale=fr</code> (French)
<code>allowLinks</code> - when <code>false</code> , disables links that take students to an external URL. Default is <code>true</code> .	<code>allowLinks=false</code>
<code>supportsPanAndZoom</code> - when <code>false</code> , disables panning and zooming using pinch-to-zoom or browser zoom controls. Default is <code>true</code> .	<code>supportsPanAndZoom=false</code>

## Insights into Student Use

- Students really enjoy composing multiple functions on the Patterns screen. If you have an objective around defining what a function is, you may want to use the single function scene.
- If your students have already learned about graphing linear functions, they may want to explicitly see the slope and y-intercept on the graph. In this sim, the graph is intended to be a more qualitative representation to complement the table and equation.
- Students can use the Equations screen to help them with the Mystery screen. They can build a function and test/modify it until they think it matches the mystery function before revealing the mystery function.



## Suggestions for Use

- Explore geometric transformations on the Patterns screen. Determine which functions are dilations, rotations, reflections, translations, or a combination. Determine which functions are not geometric.
- Check both “hide functions” and “see inside.” Advance a card through the builder and determine which functions are in the builder.



## Sample Challenge Prompts

- Choose a function for your function machine. After you drag cards through the function, discuss with your partner what you think a function is.
- Which function on the Patterns screen appears to “do nothing”? Which arithmetic functions also “do nothing”?
- Why can you drag a card backward through some functions and not others? Make up your own function that has the same quality and explain why you could not drag a card backward through it.
- Using two functions in your function machine, find an example of when the order in which you place them matters. Describe your findings. Find a different example of when the order does not matter. Summarize when the order does and does not matter.
- Create a function whose outputs appear unchanged when compared to the inputs.
- On the Equations screen, build a function and write it down. Check “see inside” and drag an output card backward through the function until it becomes the original input. Write a function that will “undo” all of your output cards, then test it out.

See all published activities for Function Builder [here](#).

For more tips on using PhET sims with your students, see [Tips for Using PhET](#).