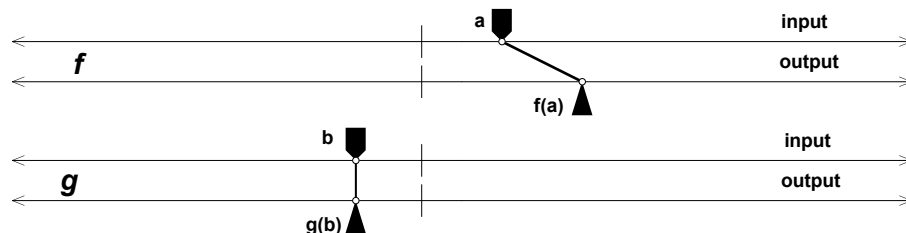# Introducing Dynagraphs

A *function* is a mechanism that gives you one specific output value for any value that you put in.

How many ways are there to represent a function? You've probably encountered various representations of functions, using tables, graphs, or equations. In this activity you'll explore a new way of representing functions: *dynagraphs.*


SKETCH AND INVESTIGATE

Q1   Spend a few moments reviewing with your group or on your own what a function is. Based on what you already know, how would you describe functions to someone who isn't familiar with them?

Each dynagraph has an input axis with an input marker and an output axis with an output marker. There is also a tick mark in the middle of each axis.

1.   Open geometricfunctions.org/links/introducing-dynagraphs. You'll see four dynagraphs labeled *f, g, h*, and *j*, each in a different color.
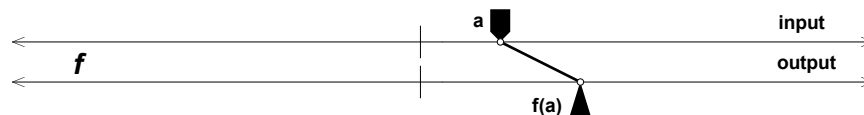
2.   The input marker for dynagraph *f* is labeled *a*. To get an idea of how dynagraphs work, use the **Arrow** tool to drag this input marker.

Q2   Based on your understanding of functions, does this dynagraph represent a function? Explain.

Next you'll explore and describe in detail each of the dynagraphs on this page.

Here's a description of the *f* dynagraph:

This description is in terms of the position and motion of the input and output markers. The description does not use numbers or formulas because there are no numbers or formulas on the dynagraphs.

When the input marker is at the tick mark, the output marker is also at the tick mark. When the input marker is not at the tick mark, the output is always on the same side of the tick mark as the input. The output is always farther away from the tick mark than the input; it seems to be about twice as far away. When the input is dragged steadily from left to right, the output also moves steadily in the same direction, only faster.

Q3   Drag the input markers for dynagraphs *g*, *h*, and *j*, and then write detailed descriptions of these functions. Imagine you're describing the dynagraphs to someone who can't see them.

NUMBERS, NUMBERS, NUMBERS

You may have thought that it would be convenient to have number lines as the dynagraph axes to make it easier to give a precise description of the behavior of each function. With only a single tick mark, it's impossible to assign numbers to positions, such as "an input of 3 gives an output of 5."

In this section you'll explore four new dynagraphs, first without numbers, then with.

3. On page 2 are the new dynagraphs. Explore each by dragging its input marker.
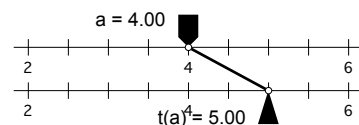
Q4 Write a description of each function, just as in the previous section.

4. Press the *Show Number Lines* button. The dynagraph axes appear as number lines.

5. Drag *t*'s input control to 4.

The arrow points to an output of 5, as shown here. Using function notation, you can write $t(4) = 5$, which is read "*t* of four equals five."

Q5 Solve for these unknowns. Be sure to use the correct function dynagraph for each one. Write each answer using function notation.

a. $t(1) =$
b. $t(5) =$
c. $t(x) = -5,\quad x =$
d. $u(-1) = g,\quad g =$
e. $u(3) = p,\quad p =$
f. $u(m) = 6,\quad m =$
g. $v(4) =$
h. $v(-4) =$
i. $v(r) = 3,\quad r =$
j. $w(2) = z,\quad z =$
k. $w(4) = s,\quad s =$
l. $w(a) = 0,\quad a =$

EXPLORE MORE

A function has an *absolute maximum* if there is a largest output value—one the function can reach but can never exceed. Similarly, a function has an *absolute minimum* if there is a smallest output value—one the function can reach but can never go below.

Q6 Of the eight functions in the sketch, which functions have an absolute maximum or an absolute minimum? What are these maximum/minimum output values, and for what input values do they occur?

Q7 The remaining pages show dynagraphs with numbers on the axes. On each page, first answer the questions. Then show the values and check your results.

Q8 On page 1, show the equations and double-tap an equation to edit it. Then drag the independent variable to investigate the behavior of your new function.