

# Function Shift Lab

Track how each change moves or resizes a function.

**HIGH SCHOOL • MA.912.F.2.1**

**MA.912.F.2.1** "Identify the effect on the graph or table of a given function after replacing  $f(x)$  by  $f(x)+k$ ,  $kf(x)$ ,  $f(kx)$  and  $f(x+k)$  for specific values of  $k$ ."

NAME \_\_\_\_\_

DATE \_\_\_\_\_

## TRANSFORMATION RULES

For  $g(x)=f(x)+k$ , add  $k$  to every output, so the graph moves up  $k$  units. In  $g(x)=kf(x)$ , multiply outputs by  $k$ ; in  $g(x)=f(kx)$ , input coordinates are divided by  $k$ ; and in  $g(x+k)$ , the graph shifts left  $k$  units. A negative multiplier in front of  $f$  reflects across the  $x$ -axis, while a negative multiplier on  $x$  inside  $f$  reflects across the  $y$ -axis.

## WORKED EXAMPLE

Let  $f(x)=4x-8$ . Write  $g(x)=f(x+8)$  in simplified form and describe the graph shift.

1. Replace  $x$  in  $f(x)$  with  $x+8$ :  $g(x)=4(x+8)-8$ .
2. Distribute:  $g(x)=4x+32-8$ .
3. Combine like terms:  $g(x)=4x+24$ .

**Answer:  $g(x)=4x+24$ . The graph of  $f$  shifts left 8 units.**

## PRACTICE 6 problems

- 1** The table shows  $f$ . For  $h(x)=f(x)+2$ , find  $h(-1)$ ,  $h(0)$ , and  $h(1)$ .  $x$ : -1, 0, 1  $f(x)$ : 3, 1, -2

**ANSWER** \_\_\_\_\_

- 2** Let  $f(x)=x^2+1$ . Write  $q(x)=-3f(x)$  in simplified form. Then describe the transformation.

**ANSWER** \_\_\_\_\_

- 3** Describe the effect on the graph of  $f$  when  $r(x)=f(2x)$ .

**ANSWER** \_\_\_\_\_

- 4** Describe the effect on the graph of  $f$  when  $s(x)=f(x-5)$ .

**ANSWER** \_\_\_\_\_

- 5** The table shows  $f$ . For  $t(x)=f(-x)$ , find  $t(-2)$ ,  $t(0)$ , and  $t(2)$ . Then name the reflection.  $x$ : -2, 0, 2  $f(x)$ : 1, 3, 5

**ANSWER** \_\_\_\_\_

- 6** Let  $f(x)=x^2+3$ . Write  $h(x)=2f(x)$  in simplified form and describe the transformation.

**ANSWER** \_\_\_\_\_

## APPLY IT Show your work

- 1** A creator tracks views on a short video in hundreds. The function  $f(t)$  gives the number of views after  $t$  days. A promotion adds 6 hundred views at every time, so  $p(t)=f(t)+6$ . If  $f(0)=3$ ,  $f(1)=5$ , and  $f(2)=9$ , find  $p(0)$ ,  $p(1)$ , and  $p(2)$ . Describe the graph change.

WORK SPACE

ANSWER \_\_\_\_\_

- 2** A DJ has a volume pattern  $f(t)$ , where  $t$  is time in seconds. Editing software creates  $r(t)=f(3t)$ . The original volume values at 2 seconds and 5 seconds are heard at what times in  $r$ ? Describe the graph change.

WORK SPACE

ANSWER \_\_\_\_\_

## CHALLENGE One step up

### CHALLENGE

Let  $p(x)=-2f(3x-5)+6$ . Describe all transformations from  $f$  to  $p$ . If the point  $(1,3)$  is on the graph of  $f$ , find its corresponding point on the graph of  $p$ .

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## PART 1 • PRACTICE

| # | PROBLEM                                                                                                                              | ANSWER                                                                                                            |
|---|--------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| 1 | The table shows $f$ . For $h(x)=f(x)+2$ , find $h(-1)$ , $h(0)$ , and $h(1)$ .<br>x: -1, 0, 1 $f(x)$ : 3, 1, -2                      | <b><math>h(-1)=5</math>, <math>h(0)=3</math>, <math>h(1)=0</math>.</b>                                            |
| 2 | Let $f(x)=x^2+1$ . Write $q(x)=-3f(x)$ in simplified form. Then describe the transformation.                                         | <b><math>q(x)=-3x^2-3</math>. The graph reflects across the x-axis and stretches vertically by a factor of 3.</b> |
| 3 | Describe the effect on the graph of $f$ when $r(x)=f(2x)$ .                                                                          | <b>The graph is compressed horizontally by a factor of <math>1/2</math>.</b>                                      |
| 4 | Describe the effect on the graph of $f$ when $s(x)=f(x-5)$ .                                                                         | <b>The graph shifts right 5 units.</b>                                                                            |
| 5 | The table shows $f$ . For $t(x)=f(-x)$ , find $t(-2)$ , $t(0)$ , and $t(2)$ . Then name the reflection. x: -2, 0, 2 $f(x)$ : 1, 3, 5 | <b><math>t(-2)=5</math>, <math>t(0)=3</math>, <math>t(2)=1</math>. The graph reflects across the y-axis.</b>      |
| 6 | Let $f(x)=x^2+3$ . Write $h(x)=2f(x)$ in simplified form and describe the transformation.                                            | <b><math>h(x)=2x^2+6</math>. The graph stretches vertically by a factor of 2.</b>                                 |

## PART 2 • APPLY IT

- $p(0)=9$ ,  $p(1)=11$ , and  $p(2)=15$ , all in hundreds of views. The graph shifts up 6 hundred views.** Add 6 to each output of  $f$ . Adding a constant to the function moves every point vertically upward by that constant.
- The original 2-second value is heard at  $2/3$  second, and the original 5-second value is heard at  $5/3$  seconds. The graph is compressed horizontally by a factor of  $1/3$ .** Set  $3t$  equal to each original time. The input multiplier 3 divides every horizontal coordinate by 3.

## CHALLENGE

**The graph is compressed horizontally by a factor of  $1/3$ , shifted right  $5/3$  units, reflected across the x-axis, stretched vertically by a factor of 2, and shifted up 6 units. The point  $(1,3)$  maps to  $(2,0)$ .**

Accept equivalent descriptions such as "horizontal shrink" for horizontal compression. For the challenge, accept the listed transformations in a logically equivalent order that gives the same final graph.