

# Input or Output?

Sort transformations by where the change happens.

**CCSS.Math.Content.HSF-BF.B.3** "Identify the effect on the graph of replacing  $f(x)$  by  $f(x) + k$ ,  $k f(x)$ ,  $f(kx)$ , and  $f(x + k)$  for specific values of  $k$  (both positive and negative); find the value of  $k$  given the graphs..."

NAME \_\_\_\_\_

DATE \_\_\_\_\_

## VERTICAL CHANGE

A vertical change changes the output, outside the function. The  $x$ -values stay the same while the  $y$ -values shift, stretch, shrink, or reflect.

If  $(2, -1)$  is on  $y = q(x)$ , then  $(2, 3)$  is on  $y = q(x) + 4$ .

## HORIZONTAL CHANGE

A horizontal change changes the input, inside the function. The graph moves, stretches, shrinks, or reflects across the  $y$ -axis horizontally.

If  $(-2, 5)$  is on  $y = r(x)$ , then  $(-5, 5)$  is on  $y = r(x + 3)$ .

## 1 SORT \_\_\_\_\_ 8 items

PART 1 SORT: For each transformation, circle VERTICAL or HORIZONTAL; PART 2 PROVE IT: Choose two item numbers and explain how the changed part of the rule told you each category.

1. From  $y = f(x)$ , graph  $y = f(x) - 5$ .

VERTICAL

HORIZONTAL

2. From  $y = f(x)$ , graph  $y = f(x + 4)$ .

VERTICAL

HORIZONTAL

3. From  $y = f(x)$ , graph  $y = f(-3x)$ .

VERTICAL

HORIZONTAL

4. From  $y = f(x)$ , graph  $y = -2f(x)$ .

VERTICAL

HORIZONTAL

5. From  $y = f(x)$ , graph  $y = f(x) + 1/2$ .

VERTICAL

HORIZONTAL

6. From  $y = f(x)$ , graph  $y = f(x/2)$ .

VERTICAL

HORIZONTAL

7. From  $y = f(x)$ , graph  $y = 0.25f(x)$ .

VERTICAL

HORIZONTAL

8. From  $y = f(x)$ , graph  $y = -f(x)$ .

VERTICAL

HORIZONTAL

## 2 PROVE IT Explain your thinking

Pick two items from Part 1. For each one, tell how you knew where it belonged.

ITEM # \_\_\_\_\_ HOW I KNEW \_\_\_\_\_

\_\_\_\_\_

ITEM # \_\_\_\_\_ HOW I KNEW \_\_\_\_\_

\_\_\_\_\_

## 3 MAKE YOUR OWN One of each

PART 3 MAKE YOUR OWN: Write one new transformation of  $y = f(x)$  that is VERTICAL and one that is HORIZONTAL.

VERTICAL

\_\_\_\_\_

\_\_\_\_\_

HORIZONTAL

\_\_\_\_\_

\_\_\_\_\_

### CHALLENGE

A point at  $(5, -2)$  on  $y = f(x)$  appears at  $(1, -2)$  on  $y = f(x + k)$ . Find  $k$  and name the direction of the shift.

\_\_\_\_\_

\_\_\_\_\_

## PART 1 • SORT

| # | ITEM                                       | CATEGORY          | WHY                                                                                                             |
|---|--------------------------------------------|-------------------|-----------------------------------------------------------------------------------------------------------------|
| 1 | From $y = f(x)$ , graph $y = f(x) - 5$ .   | <b>VERTICAL</b>   | Subtracting 5 outside the function shifts the graph down 5 units.                                               |
| 2 | From $y = f(x)$ , graph $y = f(x + 4)$ .   | <b>HORIZONTAL</b> | Adding 4 inside the input shifts the graph left 4 units.                                                        |
| 3 | From $y = f(x)$ , graph $y = f(-3x)$ .     | <b>HORIZONTAL</b> | Multiplying the input by -3 causes a horizontal compression by factor $1/3$ and a reflection across the y-axis. |
| 4 | From $y = f(x)$ , graph $y = -2f(x)$ .     | <b>VERTICAL</b>   | Multiplying the output by -2 causes a vertical stretch by factor 2 and a reflection across the x-axis.          |
| 5 | From $y = f(x)$ , graph $y = f(x) + 1/2$ . | <b>VERTICAL</b>   | Adding $1/2$ outside the function shifts the graph up $1/2$ unit.                                               |
| 6 | From $y = f(x)$ , graph $y = f(x/2)$ .     | <b>HORIZONTAL</b> | Replacing $x$ with $x/2$ causes a horizontal stretch by factor 2.                                               |
| 7 | From $y = f(x)$ , graph $y = 0.25f(x)$ .   | <b>VERTICAL</b>   | Multiplying the output by 0.25 causes a vertical shrink by factor 0.25.                                         |
| 8 | From $y = f(x)$ , graph $y = -f(x)$ .      | <b>VERTICAL</b>   | Multiplying the output by -1 reflects the graph across the x-axis.                                              |

## PART 2 • PROVE IT

Accept any explanation that names the deciding feature from the rule box for the chosen item.

## PART 3 • MAKE YOUR OWN (SAMPLE ANSWERS)

- **VERTICAL:** From  $y = f(x)$ , graph  $y = -5f(x)$ .
- **HORIZONTAL:** From  $y = f(x)$ , graph  $y = f(x - 8)$ .

**Challenge:**  $k = 4$ . The graph shifts left 4 units because  $y = f(x + 4)$ .

Classify by whether the change is outside the function, vertical, or applied to  $x$  inside the function, horizontal. Item 3 is horizontal even though the negative value also reflects the graph across the y-axis.