

## 2.2.3 How can I move a function?



### Transformations of Functions

In your Geometry course you transformed figures just like you transformed parent graphs in this course. Today you will look more at geometric transformations and you will explore what happens when you take the opposite of  $x$  before applying the operations of the function. That is, you will investigate  $f(-x)$ .

**2-121.** In Geometry, you called the transformation of figures “translations,” “reflections,” “rotations,” and “dilations.” Refer to your Parent Graph Toolkit from problem 2-104 and/or your Learning Log entry in problem 2-106 as you complete parts (a) through (d) below.

- What kind of a geometric transformation have you made when you replace  $f(x)$  with  $f(x) + k$ ? Be as specific as you can.
- What kind of geometric transformation occurs when you replace  $f(x)$  with  $-f(x)$ ? Be as specific as you can.
- What kind of transformation is  $f(x - h)$ ?
- What kind of transformation is  $a \cdot f(x)$ ? Be specific.

**2-122.** Investigate the transformation  $y = f(-x)$  as directed below.

- For each of the parent graphs you have investigated so far, investigate what happens to the graph when you replace  $x$  with  $-x$ . For each parent function, draw the original and the new graph on the same set of axes in different colors.
- For each parent equation, substitute  $-x$  for  $x$  and algebraically simplify the result.
- Describe the geometric transformation that occurs when you replace  $f(x)$  with  $f(-x)$ .

**2-123.** Functions can be categorized as **even** or **odd functions**. With your team sort the functions you investigated in problem 2-122 into the following three groups:

EVEN FUNCTIONS: All functions where  $f(-x) = f(x)$ .

ODD FUNCTIONS: All functions where  $f(-x) = -f(x)$ .

FUNCTIONS THAT ARE NEITHER EVEN nor ODD.

### 2-124. LEARNING LOG

How will the graph of a function change when  $-x$  replaces  $x$  in the function  $f(x)$ ? How can you tell from its graph whether a function will be even? How can you tell from its equation whether a function will be even? Discuss these questions with your team and then answer them in a Learning Log entry. Be sure to include examples. Title this entry “Reflections and Even Functions” and label it with today’s date.



## METHODS AND MEANINGS

### MATH NOTES

### General Equations for Families

If  $y = f(x)$  is an equation for a parent graph, then the general equation for the family of functions with similar characteristics as  $f(x)$  can be written as:

$$y = a \cdot f(x - h) + k$$

Where  $(h, k)$  is the point corresponding to  $(0, 0)$  in the parent graph and, relative to the parent graph, the function has been:

- Vertically stretched if the absolute value of  $a$  is greater than 1.
- Vertically compressed if the absolute value of  $a$  is less than 1.
- Reflected across the  $x$ -axis if  $a$  is less than 0.

So far in this chapter you have worked with the following families of functions:

Parent	Family	General Equation
$y = x$	Line	$y = a(x - h) + k$
$y =  x $	Absolute Value	$y = a x - h  + k$
$y = x^2$	Parabola	$y = a(x - h)^2 + k$
$y = x^3$	Cubic	$y = a(x - h)^3 + k$
$y = \frac{1}{x}$	Hyperbola	$y = a\left(\frac{1}{x-h}\right) + k$
$y = \sqrt{x}$	Square Root	$y = a\sqrt{x-h} + k$
$y = b^x$	Exponential	$y = ab^{(x-h)} + k$



**2-125.** Decide whether each of the following functions is even, odd, or neither. Show or explain your reasoning. [Help \(Html5\)](#)  $\Leftrightarrow$  [Help \(Java\)](#)

- $y = \frac{2}{3}x + 1$
- $y = (x + 2)^2$
- $y = |x| - x^2$

**2-126.** For each of the following functions sketch the graph of the original and of  $y = f(-x)$ . [Help \(Html5\)](#)  $\Leftrightarrow$  [Help \(Java\)](#)

- $f(x) = 2|x - 4| + 3$
- $f(x) = \frac{1}{x + 4}$
- Is either of these functions odd or even? Justify your answer.

**2-127.** A parabola has vertex  $(2, 3)$  and contains the point  $(0, 0)$ . Find an equation that represents this parabola. [Help \(Html5\)](#)  $\Leftrightarrow$  [Help \(Java\)](#)

**2-128.** For each equation below, find the  $x$ - and  $y$ -intercepts and the locator point  $(h, k)$ , then write the equations in graphing form. [Help \(Html5\)](#)  $\Leftrightarrow$  [Help \(Java\)](#)

- $y = 7 + 2x^2 + 4x - 5$
- $x^2 = 2x + x(2x - 4) + y$

**2-129.** Consider the system of equations at right: [Help \(Html5\)](#)  $\Leftrightarrow$  [Help \(Java\)](#)

$$\begin{aligned} 3y - 4x &= -1 \\ 9y + 2x &= 4 \end{aligned}$$

- What is the parent of each equation?

- b. Solve this system algebraically.
- c. Find where the two graphs intersect.
- d. Explain the relationship between parts (b) and (c) above.

**2-130.** Write an equation for each of the following sequences. [Help \(Html5\)](#)  $\Leftrightarrow$  [Help \(Java\)](#)

- a. 10, 2.5, 0.625, ...
- b. -2, -8, -14, ...

**2-131.** Find the intercepts, the locator point  $(h, k)$ , the domain, and the range for each of the following functions. [Help \(Html5\)](#)  $\Leftrightarrow$  [Help \(Java\)](#)

- a.  $y = |x - 4| - 2$
- b.  $y = -|x + 1| + 3$