# OLSEN – ACTIVITY 8 NOTES

Name ______________________________________________ Period ______

**Learning Targets:**

- Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$.
- Identify the effect on the graph of replacing $f(x)$ by $f(x + k)$.
- Identify the transformation used to produce one graph from another.

| | GROUP 1 | GROUP 2 | GROUP 3 | GROUP 4 | GROUP 5 |
|---|---|---|---|---|---|
| Parent Function | $f(x) = 2^x$ | $f(x) = x^2$ | $f(x) = x^3$ | $f(x) = \|x\|$ | $f(x) = \sqrt{x}$ |
| A. | $g(x) = x + 4$ | $g(x) = x^2 + 4$ | $g(x) = x^3 + 4$ | $g(x) = \|x\| + 4$ | $g(x) = \sqrt{x} + 4$ |
| B. | $h(x) = (x + 4)$ | $h(x) = (x + 4)^2$ | $h(x) = (x + 4)^3$ | $h(x) = \|x + 4\|$ | $h(x) = \sqrt{x + 4}$ |
| C. | $j(x) = x - 4$ | $j(x) = x^2 - 4$ | $j(x) = x^3 - 4$ | $j(x) = \|x\| - 4$ | $j(x) = \sqrt{x} - 4$ |
| D. | $k(x) = (x - 4)$ | $k(x) = (x - 4)^2$ | $k(x) = (x - 4)^3$ | $k(x) = \|x - 4\|$ | $k(x) = \sqrt{x - 4}$ |

The highlighted row is what we refer to as the **parent functions**. Parent functions are the most basic function of a particular category or type. Below you will find a list of the most common parent functions and their key attributes.

**KEY POINTS:**

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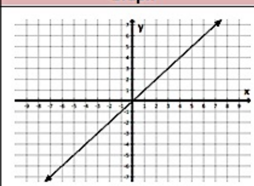
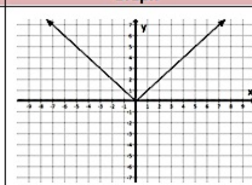
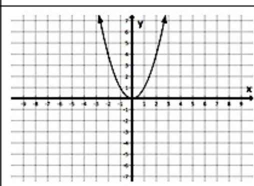
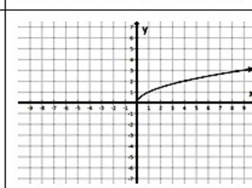
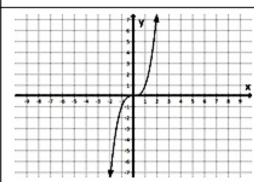
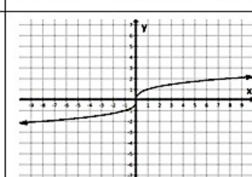
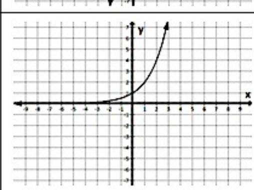
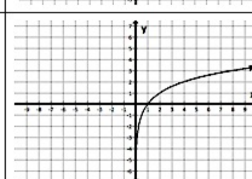
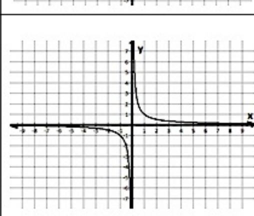
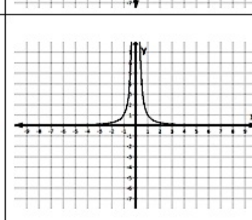
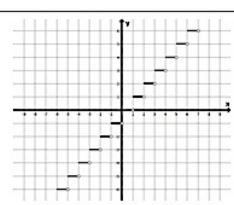
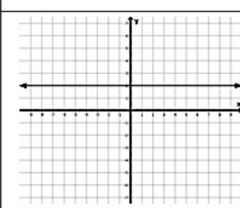
| Parent Function | Graph | Parent Function | Graph |
|---|---|---|---|
| $y = x$<br>Linear, Odd<br>Domain: $(-\infty, \infty)$<br>Range: $(-\infty, \infty)$<br>End Behavior:<br>$x \to -\infty, y \to -\infty$<br>$x \to \infty, y \to \infty$ |  | $y = \|x\|$<br>Absolute Value, Even<br>Domain: $(-\infty, \infty)$<br>Range: $[0, \infty)$<br>End Behavior:<br>$x \to -\infty, y \to \infty$<br>$x \to \infty, y \to \infty$ |  |
| $y = x^2$<br>Quadratic, Even<br>Domain: $(-\infty, \infty)$<br>Range: $[0, \infty)$<br>End Behavior:<br>$x \to -\infty, y \to \infty$<br>$x \to \infty, y \to \infty$ |  | $y = \sqrt{x}$<br>Radical, Neither<br>Domain: $[0, \infty)$<br>Range: $[0, \infty)$<br>End Behavior:<br>$x \to \infty, y \to \infty$ |  |
| $y = x^3$<br>Cubic, Odd<br>Domain: $(-\infty, \infty)$<br>Range: $(-\infty, \infty)$<br>End Behavior:<br>$x \to -\infty, y \to -\infty$<br>$x \to \infty, y \to \infty$ |  | $y = \sqrt[3]{x}$<br>Cube Root, Odd<br>Domain: $(-\infty, \infty)$<br>Range: $(-\infty, \infty)$<br>End Behavior:<br>$x \to -\infty, y \to -\infty$<br>$x \to \infty, y \to \infty$ |  |
| $y = b^x,\ b > 1$<br>Exponential, Neither<br>Domain: $(-\infty, \infty)$<br>Range: $(0, \infty)$<br>End Behavior:<br>$x \to -\infty, y \to 0$<br>$x \to \infty, y \to \infty$ |  | $y = \log_b(x),\ b > 1$<br>Log, Neither<br>Domain: $(0, \infty)$<br>Range: $(-\infty, \infty)$<br>End Behavior:<br>$x \to 0^+, y \to -\infty$<br>$x \to \infty, y \to \infty$ |  |
| $y = \frac{1}{x}$<br>Rational (Inverse), Odd<br>Domain: $(-\infty, 0) \cup (0, \infty)$<br>Range: $(-\infty, 0) \cup (0, \infty)$<br>End Behavior:<br>$x \to -\infty, y \to 0$<br>$x \to \infty, y \to 0$ |  | $y = \frac{1}{x^2}$<br>Rational (Inverse Squared), Even<br>Domain: $(-\infty, 0) \cup (0, \infty)$<br>Range: $(0, \infty)$<br>End Behavior:<br>$x \to -\infty, y \to 0$<br>$x \to \infty, y \to 0$ |  |
| $y = \text{int}(x) = [x]$<br>Greatest Integer, Neither<br>Domain: $(-\infty, \infty)$<br>Range: $\{y : y \in \mathbb{Z}\}$ (integers)<br>End Behavior:<br>$x \to -\infty, y \to -\infty$<br>$x \to \infty, y \to \infty$ |  | $y = C$<br>($y = 2$ in the graph)<br>Constant, Even<br>Domain: $(-\infty, \infty)$<br>Range: $\{y : y = C\}$<br>End Behavior:<br>$x \to -\infty, y \to C$<br>$x \to \infty, y \to C$ |  |

1. **Make use of structure.** Before you construct the table below, make a conjecture about the graph of $g(x)$, $h(x)$, $j(x)$, and $k(x)$ compared to its parent function $f(x)$ .

| | **Conjecture:** *How will each graph differ from the parent function?* |
|---|---|
| A. | |
| B. | |
| C. | |
| D. | |

2. Test your conjecture by using a graphing calculator to complete the table below and then graph $g(x)$, $h(x)$, $j(x)$, and $k(x)$.

| $x$ | $f(x) =$ | $g(x) =$ | $h(x) =$ | $j(x) =$ | $k(x) =$ |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

3. Revisit your original conjectures about $g(x)$, $h(x)$, $j(x)$, and $k(x)$ and revise if necessary. How does each graph differ from the graph of the parent function $f(x)$?

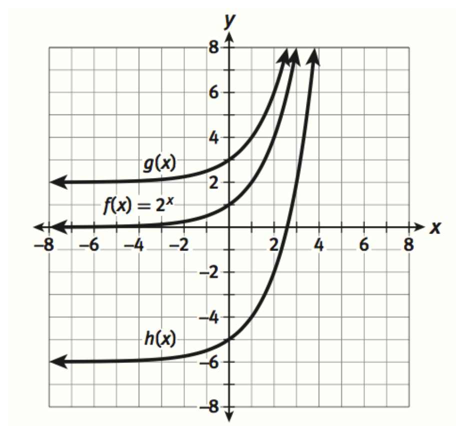
| | **Revised Conjectures:** *How does each graph differ from the parent function?* |
|---|---|
| A. | |
| B. | |
| C. | |
| D. | |

A change in the position, size, or shape of a graph is a ____________________. The changes to the graphs of $g(x)$ and $j(x)$ are examples of transformations called ____________________ ____________________ - which shift the graph __________ or __________ and preserves the shape of the graph. The changes to the graphs of $h(x)$ and $k(x)$ are examples of transformations called ____________________ ____________________ - which shift the graph __________ or __________ and also preserves the shape of the graph.

| | **Transformation Description** | **Function Notation** |
|---|---|---|
| $g(x)$ | | |
| $h(x)$ | | |
| $j(x)$ | | |
| $k(x)$ | | |

**4.** In the figure, the graphs of $g(x)$ and $h(x)$ are vertical translations of the graph of $f(x) = 2^x$.

a. Write the equation for $g(x)$.



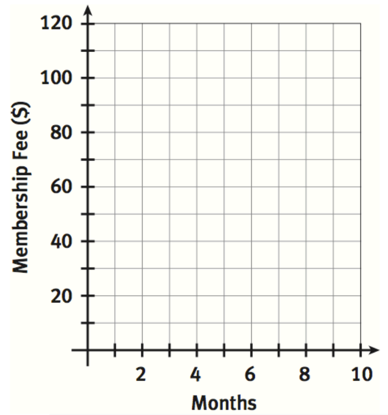

b. Write the equation for $h(x)$.

c. Without using a graphing calculator, sketch the graph of $g(x) = f(x - 8)$.

*Ray's Gym charges an initial sign-up fee of $25.00 and a monthly fee of $15.00.*

5. **Reason abstractly.** Write a function that describes the gym's total membership fee for $x$ months.

6. Graph the function you wrote in Item 5 on the grid below. Label three points on the graph.




7. Identify the $y$-intercept. What does the $y$-intercept represent?

8. How would the function change if the initial sign-up fee were increased by $5.00? How would the graph change?

**Make sense of problems.** *Julio went to a theme park in July. He paid $15 to enter the park and $3.00 for each ride. He went on x rides.*

9. Write a function that describes the total cost of Julio's trip to the theme park.

10. Julio went back to the theme park in September. The entrance fee was the same and each ride still cost $3.00. However, this time Julio went 5 more rides. Use your function from Item 9 to describe Julio's second trip.

11. How does the equation for Julio's second trip to the park change the graph of the first trip?

12. What kind of transformation describes the change from the first graph to the second graph?

13. Julio went to the park again in October and went on 8 fewer rides than he did in July. Use your function from Item 16 to describe Julio's third trip. How does this change the initial graph?

14. Julio goes to the park again in November. Now it is the off-season and the entrance is $10 less than it was in July. He goes on the same number of rides as he did in July. Write a function to describe Julio's fourth trip. How does the graph of the initial trip change this new situation?

## Check Your Understanding

**15.** Without graphing, describe the transformation from the graph of $f(x) = x^2$ to the graph of $g(x) = x^2 + 7$.

**16.** Suppose $f(x) = x - 2$. Describe the transformation from the graph of $f(x)$ to the graph of $g(x) = x + 3$.

**17.** The *y*-intercept of a function $f(x)$ is $(0, b)$. What is the *y*-intercept of $f(x) + k$?

**18.** Without graphing, describe the transformation from the graph of $f(x) = x^2$ to the graph of $g(x)$.

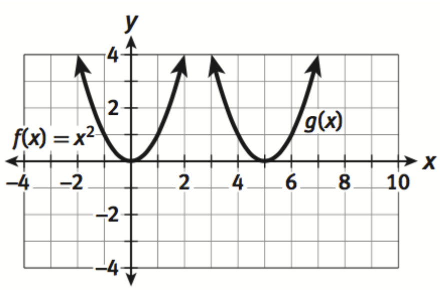
a. $g(x) = (x + 4)^2$

b. $g(x) = f(x - 7)$

c. $g(x) = (x - 2)^2 + 5$

d. $g(x) = (x + 9)^2 - 1$

**19.** The function $f(x) = x^2$ and another function $g(x)$, are graphed below. Write the equation for $g(x)$.




**20.** The *x*-intercept of a function $f(x)$ is $(a, 0)$. What is the *x*-intercept of $f(x + k)$?

**21.** Without graphing, explain how the graph of $y = (x - 4)^3$ is realted to the graph of $y = (x + 4)^3$.

**22.** The membership fee at Gina's Gym is given by the function $g(x) = 15x + 32$, where *x* is the number of months.

a. How do the fees at Gina's Gym compare to those at Ray's Gym in Item 5?

b. Without graphing, describe how the graph of $g(x)$ compares to the graph of $f(x)$.

**ACTIVITY 8 HW: page 119 – 120, "ACTIVITY 8 PRACTICE" problems 1 – 31.**

| | |
|---|---|
| 1. | 2. |
| 3. | 4. |
| 5. | 6. |
| 7. | 8. |
| 9. | 10. |
| 11. | 12. |
| 13. | 14. |
| 15. | 16. |
| 17. | 18. |
| 19. | 20. |
| 21. | 22. |
| 23. | 24. |
| 25. | 26. |
| 27. | 28. |
| 29. | 30. |
| 31. | |

# ACTIVITY 8 EXTRA PRACTICE

In Items 1 – 8, identify the transformation from the graph of $f(x) = |x|$ to the graph of $g(x)$.

1. $g(x) = |x| + 2$
2. $g(x) = |x - 3|$
3. $g(x) = |x| - 1$
4. $g(x) = |x + 8|$
5. $g(x) = |x - 5| + 6$
6. $g(x) = |x + 11| + 1$
7. $g(x) = |x - 3| - 3$
8. $g(x) = |x + 2| - 4.7$

For Items 9 – 16, write the equation $g(x)$ of the function described by each of the following transformations of the graph of $f(x) = \sqrt[3]{x}$.

9. Translated 5 units to the right of $f(x)$.
   a. Write the equation.
   b. Write the equation in function notation.
10. Translated 7 units down from $f(x)$.
    a. Write the equation.
    b. Write the equation in function notation.
11. Translated 1 unit left, and 6 units down from $f(x)$.
    a. Write the equation.
    b. Write the equation in function notation.
12. Translated 8 units left of $f(x)$.
    a. Write the equation.
    b. Write the equation in function notation.
13. Translated 9 units up, and 13 units to the right of $f(x)$.
    a. Write the equation.
    b. Write the equation in function notation.

14. Translated 2 units up from $f(x)$.

   a. Write the equation.

   b. Write the equation in function notation.

15. Translated 7 units left, and 1 unit up from $f(x)$.

   a. Write the equation.

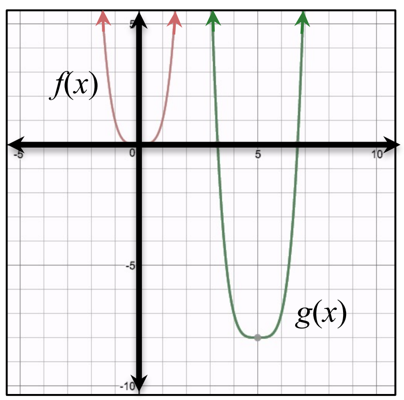
   b. Write the equation in function notation.

16. Translated down 3 units, and 9 units right from $f(x)$.

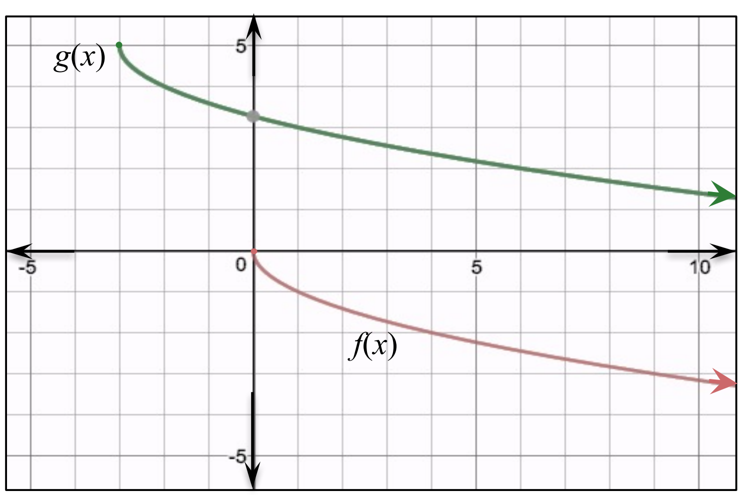
   a. Write the equation.

   b. Write the equation in function notation.

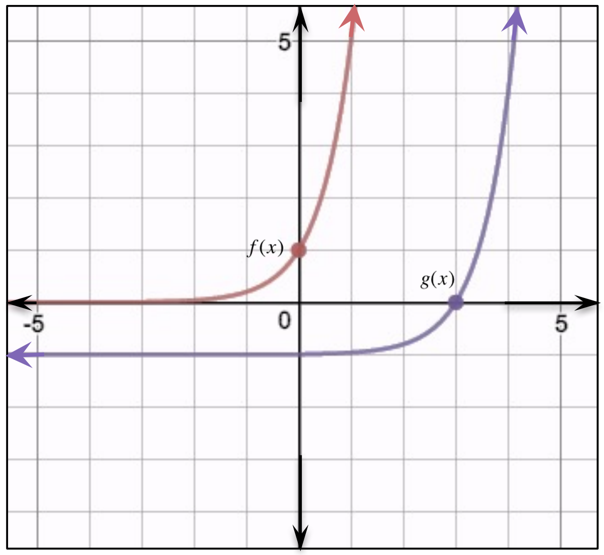
17. The figure shows the graph of $f(x) = x^4$ and the graph of $g(x)$. Write an equation for the graph of $g(x)$.




18. The figure shows the graph of $f(x) = -\sqrt{x}$ and the graph of $g(x)$. Write an equation for the graph of $g(x)$.



19. The figure shows the graph of $f(x)=5^x$ and the graph of $g(x)$. Write an equation for the graph of $g(x)$.




20. Caitlin put $5,000 down on a $20,000 car and has to make $350 payments in order to pay off the balance on the car. Write a function that describes the amount of money Caitlin has left to pay on her car.

21. Jeff put $7,000 down on a $20,000 car and also has to make $350 payments in order to pay off the balance on the car. Write a function that describes the amount of money Jeff has left to pay on his car.

22. How does the equation for Jeff's balance change the graph of Caitlin's balance?

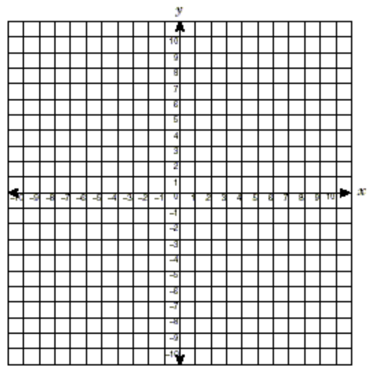
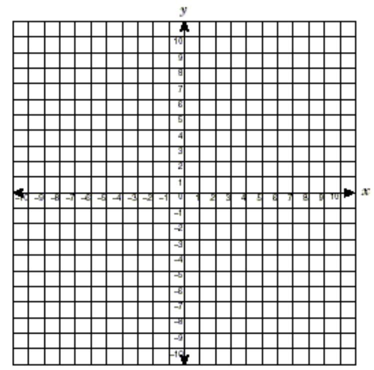
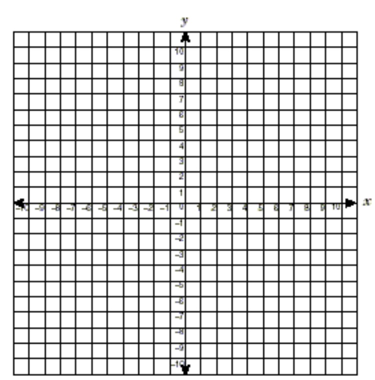
23. If Caitlin made $x$ payments, and Jeff made 3 less payments than Caitlin, write a new function that describes the amount of money Jeff has left to pay on his car.

24. How does the new equation for Jeff's balance change the graph of Caitlin's balance?

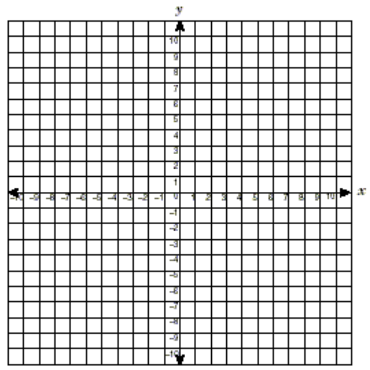
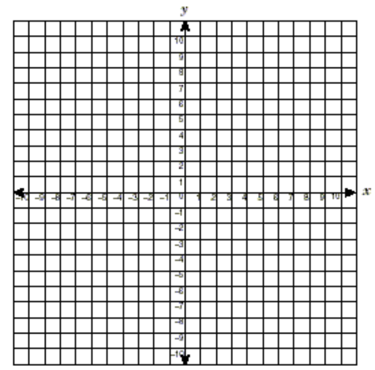
25. Isaias drew the graph of $f(x)=x^3$. Then, he translated the graph 4 units down to get the graph of $g(x)$. Next, he translated the graph 7 units left and 6 units up to get the graph of $h(x)$. What is the equation of $h(x)$?

# WANT EVEN MORE EXTRA PRACTICE?

**Page 114, "LESSON 8-1 PRACTICE" problems 17 – 23.**

| | |
|---|---|
| 16.  | 17.  |
| 18. | 19. |
| 20. | 21. |
| 22. | 23.  |

**Page 118, “LESSON 8-2 PRACTICE” problems 16 – 21.**

<table>
<tr><td>16.<br></td><td>17.<br></td></tr>
<tr><td>18.</td><td>19.</td></tr>
<tr><td colspan="2">20.</td></tr>
</table>