

# Graphing Functions and Transformations

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Score: \_\_\_\_\_ / 26

## Quick Review

**To graph a function:** build a table of  $(x, y)$  points, plot them, connect with a smooth curve (or line if linear). Pick  $x$ -values on both sides of 0. **Key features:** the  $y$ -intercept is where the graph hits the  $y$ -axis (set  $x = 0$ ). The  $x$ -intercepts (zeros) are where it hits the  $x$ -axis (set  $y = 0$ ). The graph is **increasing** when it goes up left-to-right and **decreasing** when it goes down. **Transformations** from a parent function  $f(x)$ :  $f(x) + k$  shifts up by  $k$  (down if  $k < 0$ );  $a \cdot f(x)$  with  $|a| > 1$  is a vertical stretch (narrower); with  $|a| < 1$  a compression (wider);  $-f(x)$  reflects over the  $x$ -axis (flips upside down).

## PRACTICE

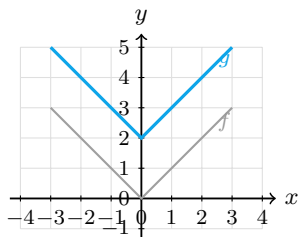
Find intercepts or describe transformations.

- |   |       |   |       |
|---|-------|---|-------|
| 1. $f(x) = 3x - 6$ ; intercepts             | _____ | 11. $g(x) = (x - 3)^2$ vs. $x^2$          | _____ |
| 2. $f(x) = x^2 - 9$ ; $x$ -intercepts       | _____ | 12. $g(x) = -2x^2$ vs. $x^2$              | _____ |
| 3. $f(x) = -2x + 4$ ; intercepts            | _____ | 13. $f(x) = 2x + 8$ ; intercepts          | _____ |
| 4. $g(x) = x^2 + 5$ vs. $f(x) = x^2$        | _____ | 14. $f(x) = x^2 - x - 6$ ; $x$ -int       | _____ |
| 5. $g(x) = -x^2$ vs. $f(x) = x^2$           | _____ | 15. $g(x) =  x  + 1$ vs. $ x $            | _____ |
| 6. $g(x) = \frac{1}{2}x^2$ vs. $f(x) = x^2$ | _____ | 16. $f(x) = -\frac{1}{2}x + 3$ ; $y$ -int | _____ |
| 7. $f(x) =  x  - 2$ ; intercepts            | _____ | 17. $g(x) = x^3 + 4$ vs. $x^3$            | _____ |
| 8. $g(x) = 3 x $ vs. $f(x) =  x $           | _____ | 18. $f(x) = 5$ ; intercepts               | _____ |
| 9. $g(x) = x^2 + 2$ vs. $x^2$               | _____ | 19. $f(x) = x^2 + 4$ ; $x$ -int           | _____ |
| 10. $f(x) = 4x$ ; intercepts                | _____ | 20. $g(x) = (x + 2)^2 - 3$ vs. $x^2$      | _____ |

## VISUAL PRACTICE

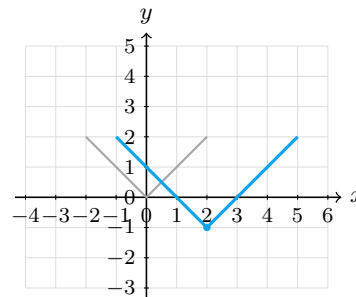
Use the graph, table, chart, or diagram to answer the question.

21. The graph of  $f(x) = |x|$  is shifted to make  $g(x) = |x| + 2$ . What changed?



Answer: \_\_\_\_\_

22. The graph of  $f(x) = |x|$  is shifted. What is the new vertex?



Answer: \_\_\_\_\_



## ◆ Word Problems

23. A company's profit (thousands of dollars) is  $P(x) = x^2 - 6x + 8$ , where  $x$  is hundreds of units sold. At what unit sales does profit equal zero?

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

24. Describe the transformations needed to graph  $g(x) = -x^2 + 5$  starting from  $f(x) = x^2$ . State the vertex and direction.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

25. A ball is launched from ground level, and its height is modeled by  $h(t) = -16t^2 + 32t$  feet. Use the equation to determine when the ball returns to the ground.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_

26. A linear function representing a simple cost model passes through  $(0, 4)$  and  $(2, 10)$ . Find the intercepts and explain which point gives the  $y$ -intercept immediately.

Model: \_\_\_\_\_

Answer: \_\_\_\_\_



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## Answer Keys

- |  |   |
|--|---|
| <p>1. <math>y</math>-int <math>(0, -6)</math>, <math>x</math>-int <math>(2, 0)</math></p> <p>2. <math>x = \pm 3</math></p> <p>3. <math>y = (0, 4)</math>, <math>x = (2, 0)</math></p> <p>4. shift up 5</p> <p>5. reflect over <math>x</math>-axis</p> <p>6. vertical compression</p> <p>7. <math>y = (0, -2)</math>, <math>x = (\pm 2, 0)</math></p> <p>8. vertical stretch</p> <p>9. shift up 2</p> <p>10. both at <math>(0, 0)</math></p> <p>11. shift right 3</p> <p>12. reflect and stretch</p> <p>13. <math>y = (0, 8)</math>, <math>x = (-4, 0)</math></p> | <p>14. <math>x = 3</math> or <math>x = -2</math></p> <p>15. shift up 1</p> <p>16. <math>(0, 3)</math></p> <p>17. shift up 4</p> <p>18. <math>y = (0, 5)</math>, no <math>x</math>-int</p> <p>19. none</p> <p>20. left 2, down 3</p> <p>21. shift up 2</p> <p>22. <math>(2, -1)</math></p> <p>23. <math>x = 2</math>, <math>x = 4</math></p> <p>24. reflect over <math>x</math>-axis, shift up 5; <math>(0, 5)</math>, opens down</p> <p>25. <math>t = 2</math> sec</p> <p>26. <math>y = (0, 4)</math>, <math>x = (-\frac{4}{3}, 0)</math></p> |
|--|---|

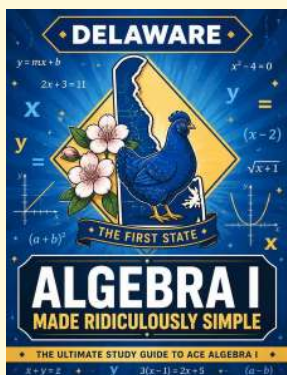
### Step-by-Step Tutor Notes

- Read the table by matching the correct row and column first, then use the count or total that fits the question.  $y$ -int:  $f(0) = -6$ .  $x$ -int:  $3x - 6 = 0 \Rightarrow x = 2$ . This gives  $y$ -int  $(0, -6)$ ,  $x$ -int  $(2, 0)$ .
- Set  $x^2 - 9 = 0$ . Factor:  $(x - 3)(x + 3) = 0$ . So  $x = 3$  or  $x = -3$ .
- Read the table by matching the correct row and column first, then use the count or total that fits the question.  $y$ -int:  $f(0) = 4$ .  $x$ -int:  $-2x + 4 = 0 \Rightarrow x = 2$ . This gives  $y = (0, 4)$ ,  $x = (2, 0)$ .
- Work one inverse operation at a time and keep both sides balanced. Adding 5 outside the squaring moves every point up by 5. After simplifying, the answer is shift up 5.
- Start with the definition the problem is testing, then apply it directly. The negative flips the parabola upside down — opens downward now. So the answer is reflect over  $x$ -axis.
- Move carefully through the arithmetic; one clean operation usually unlocks the next one. Multiplying by  $\frac{1}{2}$  (less than 1) makes the parabola wider/flatter. After simplifying, the answer is vertical compression.
- $y$ -int:  $f(0) = |0| - 2 = -2$ .  $x$ -int:  $|x| - 2 = 0$ , so  $|x| = 2$ , giving  $x = \pm 2$ .
- For a table question, slow down and locate the exact row, column, or cell before calculating. Multiplying by 3 (greater than 1) makes the V-shape narrower/steeper. This gives vertical stretch.
- This is a good place to slow down, check the notation, and simplify cleanly. Same shape, every point moves up 2. So the answer is shift up 2.
- For a table question, slow down and locate the exact row, column, or cell before calculating.  $f(0) = 0$  and  $4x = 0 \Rightarrow x = 0$ . The line passes through the origin. This gives both at  $(0, 0)$ .
- Subtracting 3 from  $x$  inside the function moves the graph right by 3 (horizontal shifts are counter-intuitive).
- Take it one clear step at a time and keep the original question in mind. Two transformations: the negative flips it, and the 2 stretches it vertically. So the answer is reflect and stretch.
- Read the table by matching the correct row and column first, then use the count or total that fits the question.  $y$ -int = 8.  $x$ -int:  $2x + 8 = 0 \Rightarrow x = -4$ . This gives  $y = (0, 8)$ ,  $x = (-4, 0)$ .
- Use the structure of the expression to find the important point, then check that it fits the context. Factor:  $(x - 3)(x + 2) = 0$ . Two  $x$ -intercepts. That leads to  $x = 3$  or  $x = -2$ .
- Keep the order of operations in view, then simplify without skipping the sign check. Adding 1 outside the absolute value lifts the V by 1. After simplifying, the answer is shift up 1.
- Line up the two changes first; that keeps the rate from getting mixed up.  $f(0) = 3$ . (The  $y$ -intercept in slope-intercept form is just the constant term.) So the requested value is  $(0, 3)$ .
- Take it one clear step at a time and keep the original question in mind.  $+4$  outside the function shifts the whole cubic up by 4. So the answer is shift up 4.
- $y$ -int is 5. But 5 is never 0, so there are no  $x$ -intercepts (horizontal line above the  $x$ -axis).
- $x^2 + 4 = 0$  would need  $x^2 = -4$ , which is impossible for real  $x$ . No  $x$ -intercepts. (Parabola sits entirely above the  $x$ -axis).
- $(x + 2)$  inside shifts left 2 (opposite of what you'd expect), and  $-3$  outside shifts down 3.
- Move carefully through the arithmetic; one clean operation usually unlocks the next one. Adding 2 outside the function moves every point up 2 units. After simplifying, the answer is shift up 2.
- Look for the key feature the question asks about, such as a zero, intercept, or vertex. The new graph has its corner at  $(2, -1)$ , so that is the new vertex. That leads to  $(2, -1)$ .
- Set  $P(x) = 0$ :  $x^2 - 6x + 8 = 0$ . Factor:  $(x - 2)(x - 4) = 0$ . So  $x = 2$  or  $x = 4$ . The company breaks even at 200 units and 400 units. Between them, profit is negative (a loss).
- The negative reflects the parabola over the  $x$ -axis (now opens down). The  $+5$  shifts everything up 5. Result: a downward parabola with vertex  $(0, 5)$ .
- Ground means  $h = 0$ :  $-16t^2 + 32t = 0$ . Factor:  $-16t(t - 2) = 0$ , so  $t = 0$  or  $t = 2$ . The ball starts at the ground ( $t = 0$ ) and comes back at  $t = 2$  seconds.
- Slope =  $\frac{10-4}{2-0} = 3$ , so  $y = 3x + 4$ .  $y$ -intercept already given:  $(0, 4)$ .  $x$ -intercept:  $3x + 4 = 0 \Rightarrow x = -\frac{4}{3}$ .



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