

TOPIC 19: Translations of Graphs

The process of moving a graph to the left and right, or up and down, is called **translation**. We will start by exploring translations of the parabola with equation $y = x^2$. Recall that we can represent the quadratic function $y = x^2$ in function notation by letting $y = f(x)$.

Example 1: Let $f(x) = x^2$. Graph $y = f(x) - 4$ on your calculator and compare it to the graph of $y = f(x)$.

We start by replacing $f(x)$ with x^2 in the equation $y = f(x) - 4$ to obtain $y = x^2 - 4$. Now we graph $y = x^2 - 4$ on the calculator along with $y = x^2$ so that we can compare the two graphs. Press the $\boxed{Y=}$ key and type in the two equations. Then press the **GRAPH** key.



We see that the graph of $f(x) = x^2$ has *moved down 4 units* to give the graph of $y = f(x) - 4$. Notice that $y = x^2$ is graphed first and $y = x^2 - 4$ is graphed second.

For problems 1-4, let $f(x) = x^2$. Graph the equation and compare it to the graph of $y = f(x)$. Begin by rewriting the equation as in Example 1.

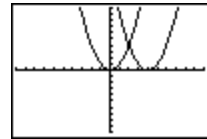
- | | |
|-------------------|-------------------|
| 1. $y = f(x) + 3$ | 2. $y = f(x) + 5$ |
| 3. $y = f(x) - 3$ | 4. $y = f(x) - 5$ |

5. Briefly describe the graph of $y = x^2 + k$. Use complete sentences.

Example 2: Let $f(x) = x^2$. Graph $y = f(x-4)$ on your calculator and compare it to the graph of $y = f(x)$.

Replace x with $x-4$ in the equation $f(x) = x^2$ to obtain $y = f(x-4) = (x-4)^2$. Now type $y = x^2$ and $y = (x-4)^2$ into your calculator and graph the equations.

Example 2:
(continued)



We see that the graph of $f(x) = x^2$ has moved 4 units to the right to give the graph of $y = f(x-4)$.

For exercises 6-9, let $f(x) = x^2$. Graph the equation and compare it to the graph of $y = f(x)$. Begin by rewriting the equation as in Example 2.

6. $y = f(x-3)$

7. $y = f(x-5)$

8. $y = f(x+3)$

9. $y = f(x+5)$

10. Briefly describe the graph of $y = (x-h)^2$. Use complete sentences. (Note: There is a negative sign in front of the h which will affect the direction of the movement.)

For exercises 11-14, let $f(x) = x^2$. Graph the equation and compare it to the graph of $y = f(x)$.

11. $y = f(x-4)+3$

12. $y = f(x+2)-1$

13. $y = f(x-7)-5$

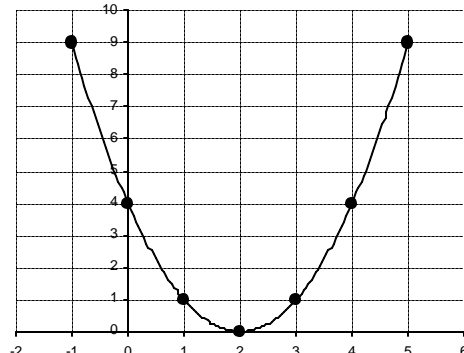
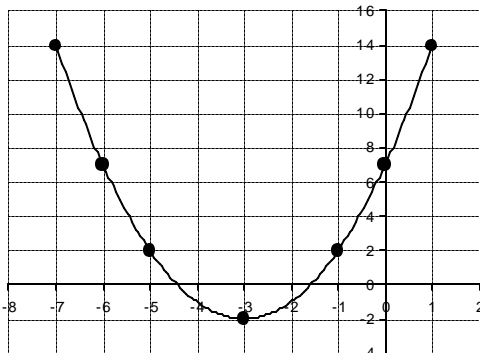
14. $y = f(x+9)+3$

15. Briefly describe the graph of $y = (x-h)^2 + k$. Use complete sentences.

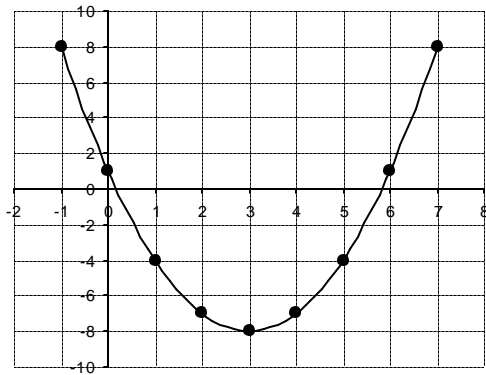
For exercises 16-19, write an equation for the graph.

16.

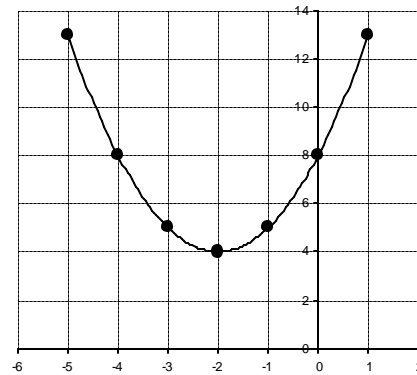
17.



18.



19.



20. Looking at the graphs in exercises 16-19, and the equations you wrote to go with them, describe how to find the vertex of a parabola with equation $y = (x - h)^2 + k$.

For exercises 21 and 22, write the equation in the form $y = (x - h)^2 + k$ by *completing the square on x* and find the vertex of the parabola.

21. $y = x^2 - 4x + 7$

22. $y = x^2 + 6x - 1$

The graph of $y = f(x - h) + k$ is a translation of the graph with equation $y = f(x)$. So far we have explored translations of parabolas. Now we will explore translations of the graphs of some other common functions.

23. Let $f(x) = |x|$. Graph $y = f(x + 3) - 1$ and $y = f(x)$. Briefly compare the graphs using complete sentences.

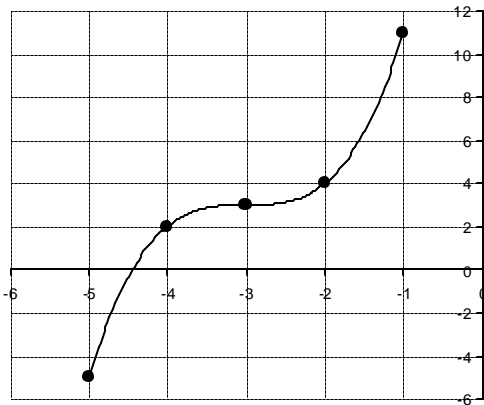
24. Let $f(x) = \sqrt{x}$. Graph $y = f(x - 2) + 5$ and $y = f(x)$. Briefly compare the graphs using complete sentences.

25. Let $f(x) = x^3$. Graph $y = f(x + 1) + 3$ and $y = f(x)$. Briefly compare the graphs using complete sentences.

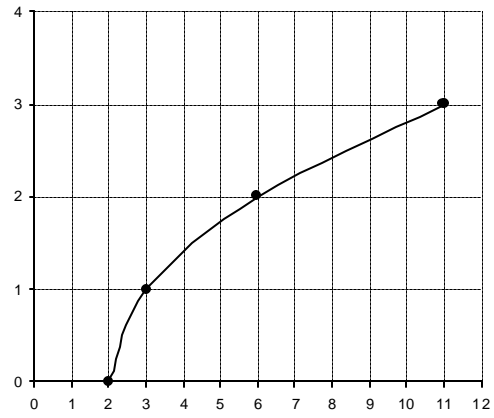
26. How is the graph of $y = f(x - h) + k$ obtained from the graph of $y = f(x)$?

For exercises 27-29, write an equation for the graph.

27.



28.



29.

