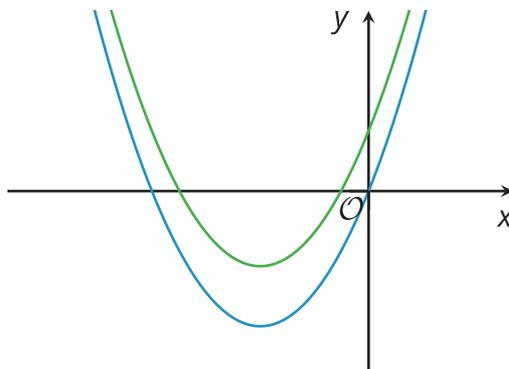


# Lesson 17: Changing the Vertex

- Let's write new quadratic equations in vertex form to produce certain graphs.

## 17.1: Graphs of Two Functions



Here are graphs representing the functions  $f$  and  $g$ , given by  $f(x) = x(x + 6)$  and  $g(x) = x(x + 6) + 4$ .

1. Which graph represents each function? Explain how you know.
  
2. Where does the graph of  $f$  meet the  $x$ -axis? Explain how you know.

## 17.2: Shifting the Graph

1. How would you change the equation  $y = x^2$  so that the vertex of the graph of the new equation is located at the following coordinates and the graph opens as described?
  - a.  $(0, 11)$ , opens up
  
  - b.  $(7, 11)$ , opens up
  
  - c.  $(7, -3)$ , opens down
  
2. Use graphing technology to verify your predictions. Adjust your equations if necessary.
  
3. Kiran graphed the equation  $y = x^2 + 1$  and noticed that the vertex is at  $(0, 1)$ . He changed the equation to  $y = (x - 3)^2 + 1$  and saw that the graph shifted 3 units to the right and the vertex is now at  $(3, 1)$ .

Next, he graphed the equation  $y = x^2 + 2x + 1$ , observed that the vertex is at  $(-1, 0)$ . Kiran thought, "If I change the squared term  $x^2$  to  $(x - 5)^2$ , the graph will move 5 units to the right and the vertex will be at  $(4, 0)$ ."

Do you agree with Kiran? Explain or show your reasoning.

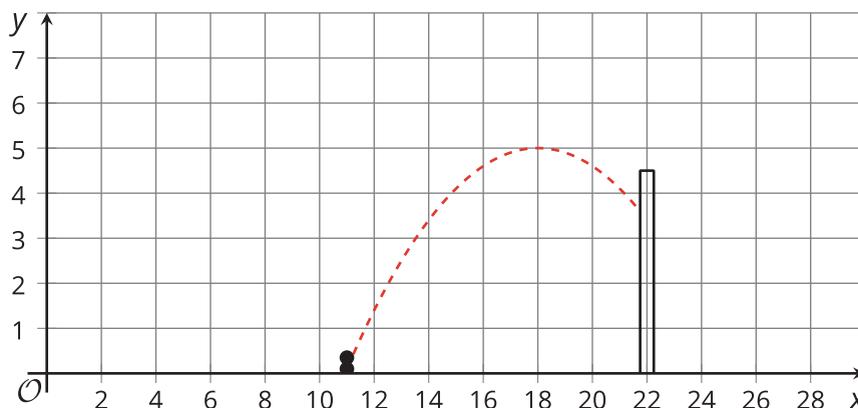
## 17.3: A Peanut Jumping over a Wall

Mai is learning to create computer animation by programming. In one part of her animation, she uses a quadratic function to model the path of the main character, an animated peanut, jumping over a wall.



Mai uses the equation  $y = -0.1(x - h)^2 + k$  to represent the path of the jump.  $y$  represents the height of the peanut as a function of the horizontal distance it travels,  $x$ .

On the screen, the base of the wall is located at  $(22, 0)$ , with the top of the wall at  $(22, 4.5)$ . The dashed curve in the picture shows the graph of 1 equation Mai tried, where the peanut fails to make it over the wall.

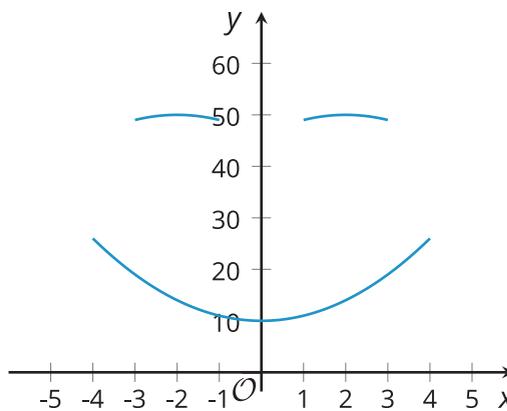


1. What are the values of  $h$  and  $k$  in this equation?
2. Starting with Mai's equation, choose values for  $h$  and  $k$  that will guarantee the peanut stays on the screen but also makes it over the wall. Be prepared to explain your reasoning.

## 17.4: Smiley Face

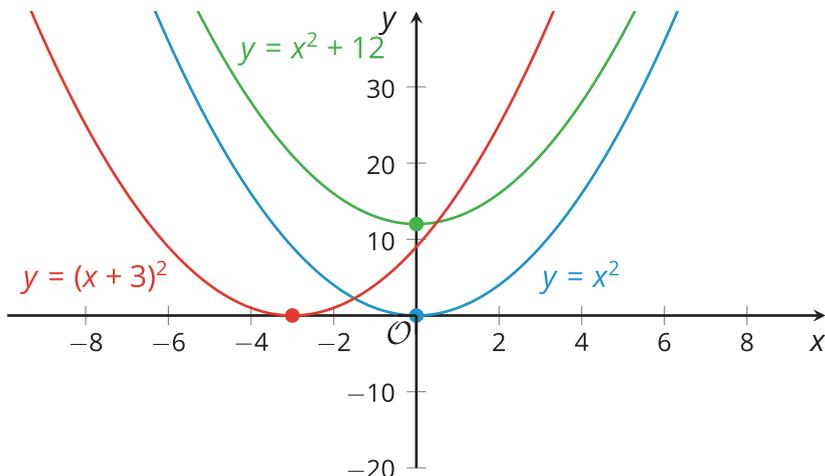
Do you see 2 “eyes” and a smiling “mouth” on the graph? The 3 arcs on the graph all represent quadratic functions that were initially defined by  $y = x^2$ , but whose equations were later modified.

1. Write equations to represent each curve in the smiley face.
2. What domain is used for each function to create this graph?



## Lesson 17 Summary

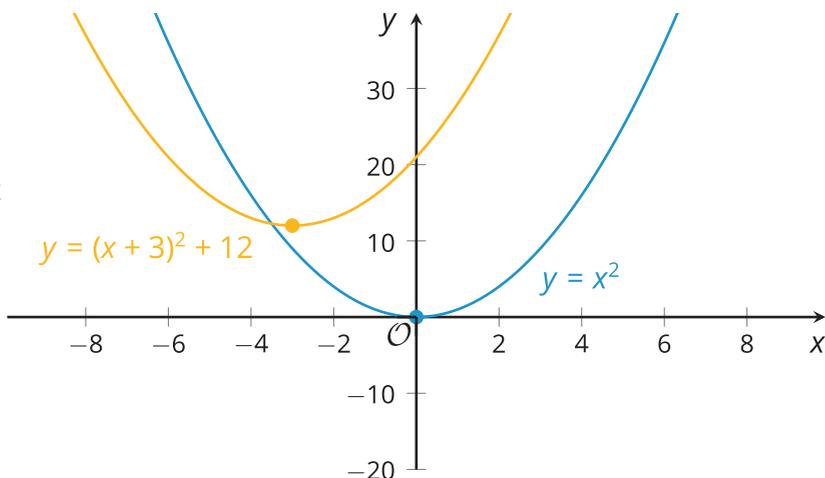
The graphs of  $y = x^2$ ,  $y = x^2 + 12$  and  $y = (x + 3)^2$  all have the same shape but their locations are different. The graph that represents  $y = x^2$  has its vertex at  $(0, 0)$ .



Notice that adding 12 to  $x^2$  raises the graph by 12 units, so the vertex of that graph is at  $(0, 12)$ . Replacing  $x^2$  with  $(x + 3)^2$  shifts the graph 3 units to the left, so the vertex is now at  $(-3, 0)$ .

We can also shift a graph both horizontally and vertically.

The graph that represents  $y = (x + 3)^2 + 12$  will look like that for  $y = x^2$  but it will be shifted 12 units up and 3 units to the left. Its vertex is at  $(-3, 12)$ .



The graph representing the equation  $y = -(x + 3)^2 + 12$  has the same vertex at  $(-3, 12)$ , but because the squared term  $(x + 3)^2$  is multiplied by a negative number, the graph is flipped over horizontally, so that it opens downward.

