

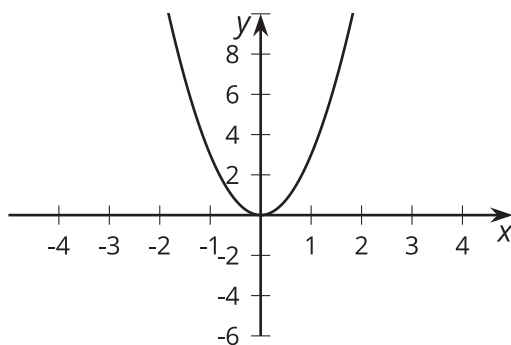
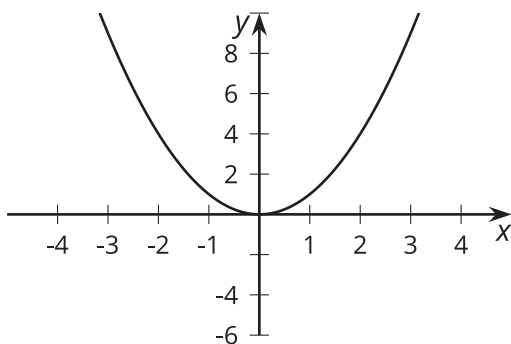
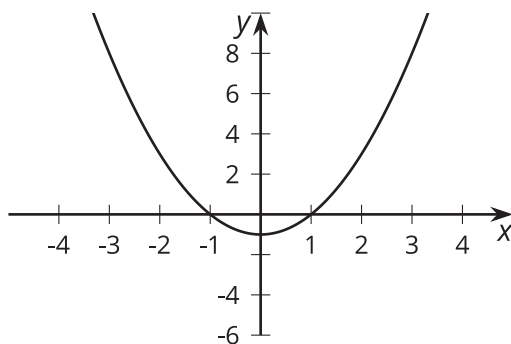
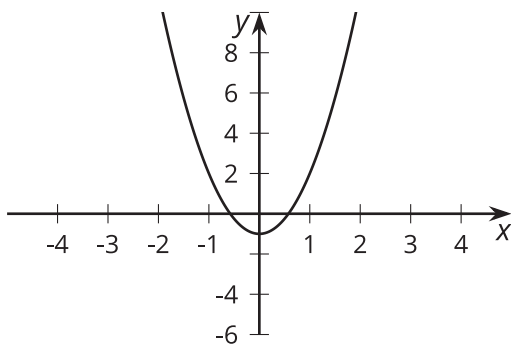
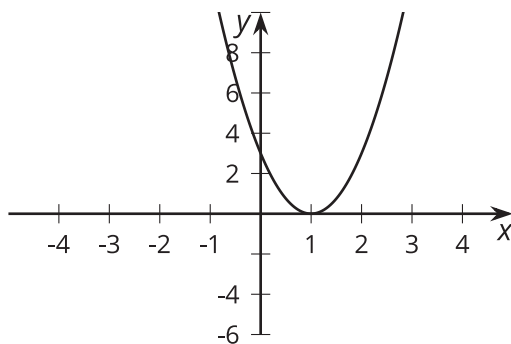
# Amplitude and Midline

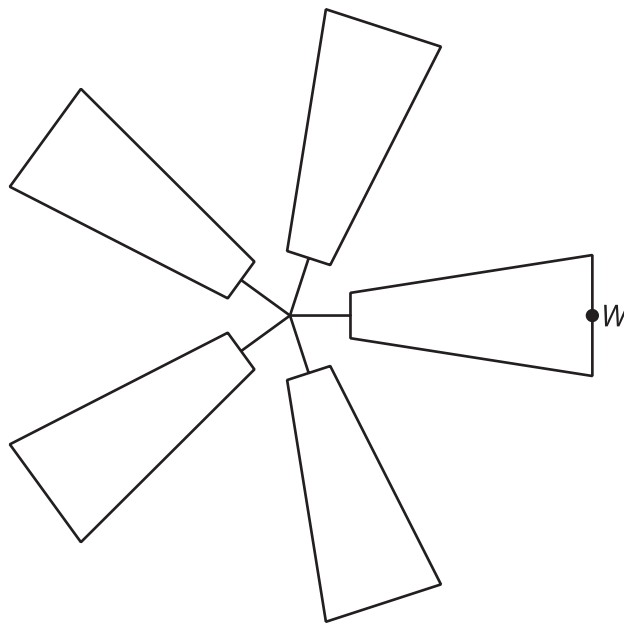
Let's transform the graphs of trigonometric functions.

## 14.1 Comparing Parabolas

Match each equation to its graph. Be prepared to explain how you know which graph belongs with each equation.

1.  $y = x^2$
2.  $y = 3x^2$
3.  $y = 3(x - 1)^2$
4.  $y = 3x^2 - 1$
5.  $y = x^2 - 1$

**A****B****C****D****E**



Suppose a windmill has a radius of 1 meter, and the center of the windmill is at  $(0, 0)$  on a coordinate grid.

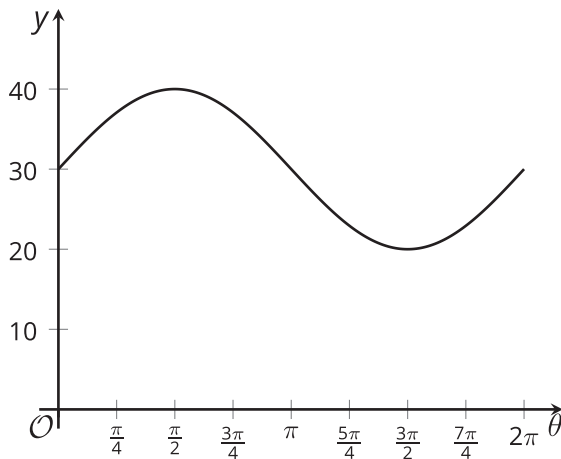
1. Write a function describing the relationship between the height,  $h$ , of  $W$  and the angle of rotation,  $\theta$ . Explain your reasoning.
2. Describe how your function and its graph would change if:
  - a. the windmill blade has a length of 3 meters.
  - b. the windmill blade has a length of 0.5 meter.
3. Test your predictions using graphing technology.

## 14.3 Up, Up, and Away

1. A windmill has a radius of 1 meter, and its center is 8 meters off the ground. A point,  $W$ , starts at the tip of a blade in the position farthest to the right and rotates counterclockwise. Write a function describing the relationship between the height,  $h$ , of  $W$ , in meters, and the angle,  $\theta$ , of rotation.
2. Graph your function using technology. How does it compare to the graph where the center of the windmill is at  $(0, 0)$ ?
3. What would the graph look like if the center of the windmill were 11 meters off the ground? Explain how you know.

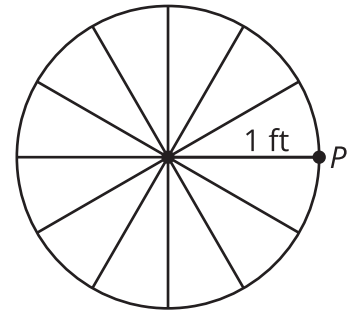
### Are you ready for more?

Here is the graph of a different function describing the relationship between the height,  $y$ , in feet, of the tip of a blade and the angle of rotation,  $\theta$ , made by the blade. Describe the windmill.



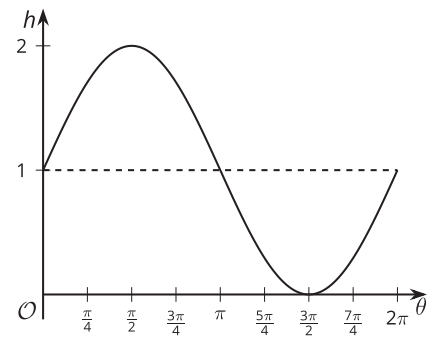
## Lesson 14 Summary

Suppose a bike wheel has a radius of 1 foot and we want to determine the height of a point,  $P$ , on the wheel as it spins in a counterclockwise direction. The height,  $h$ , in feet of point  $P$  can be modeled by the equation  $h = \sin(\theta) + 1$ , where  $\theta$  is the angle of rotation of the wheel. As the wheel spins in a counterclockwise direction, the point first reaches a maximum height of 2 feet when it is at the top of the wheel, and then a minimum height of 0 feet when it is at the bottom.



The graph of the height of  $P$  looks just like the graph of the sine function but it has been raised by 1 unit:

The horizontal line  $h = 1$ , shown here as a dashed line, is called the **midline** of the graph.



What if the wheel had a radius of 11 inches instead? How would that affect the height,  $h$ , in inches, of point  $P$  over time?

This wheel can also be modeled by a sine function,  $h = 11 \sin(\theta) + 11$ , where  $\theta$  is the angle of rotation of the wheel. The graph of this function has the same wavelike shape as the sine function, but its midline is at  $h = 11$  and its **amplitude** is different:

The amplitude of the function is the length from the midline to the maximum value, shown here with a dashed line, or, since they are the same, the length from the minimum value to the midline. For the graph of  $h = 11 \sin(\theta) + 11$ , the midline value is 11 and the maximum is 22. This means that the amplitude is 11 since  $22 - 11 = 11$ .

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