Unit 7, Lesson 14

# Amplitude and Midline

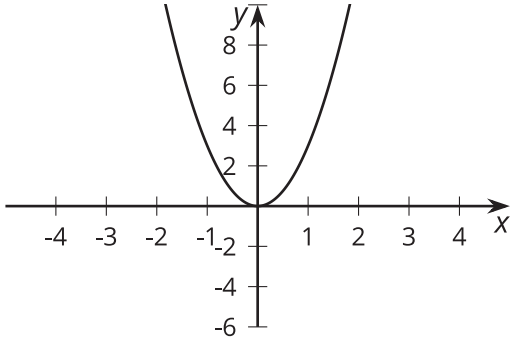
Let's transform the graphs of trigonometric functions.

## 14.1 Comparing Parabolas

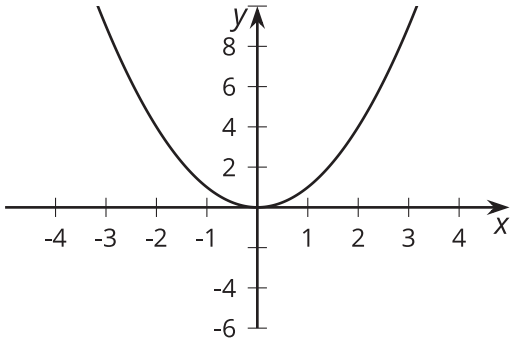
Match each equation to its graph. Be prepared to explain how you know which graph belongs with each equation.

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

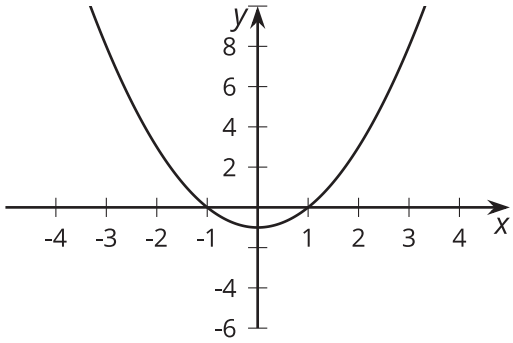
**A**



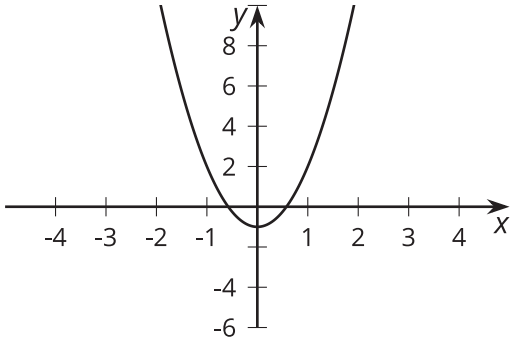

**B**



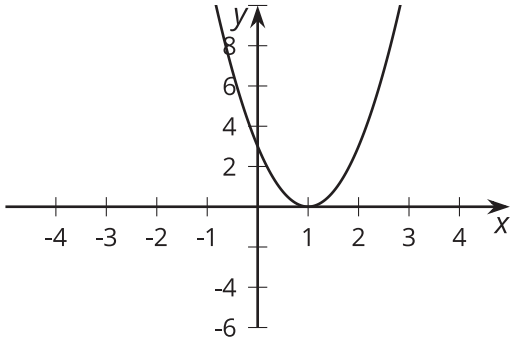

**C**



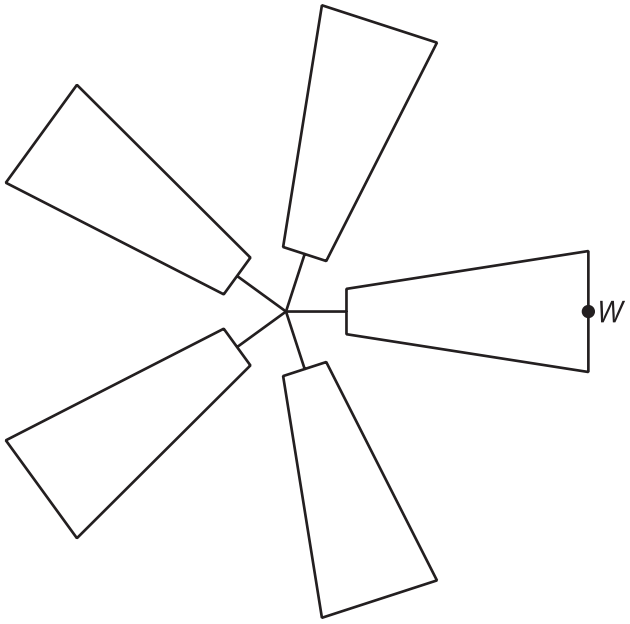

**D**




**E**



# 14.2 Blowing in the Wind




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

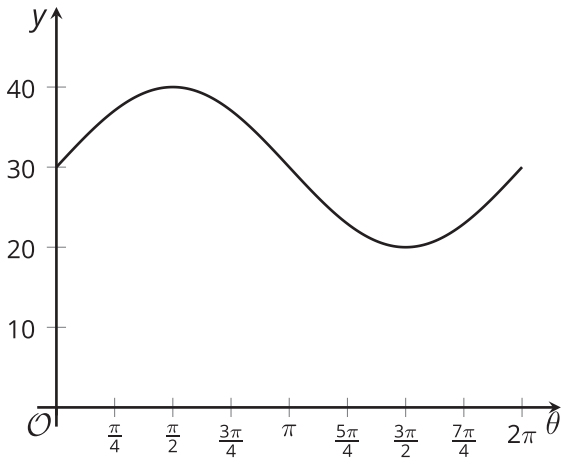
1. A windmill has a radius of 1 meter, and its center is 8 meters off the ground. A point, $W$, starts at the tip of a blade in the position farthest to the right and rotates counterclockwise. Write a function describing the relationship between the height, $h$, of $W$, in meters, and the angle, $\theta$, 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.

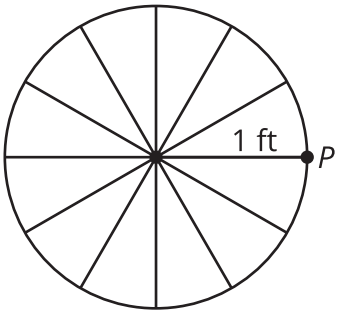
## Are you ready for more?

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.



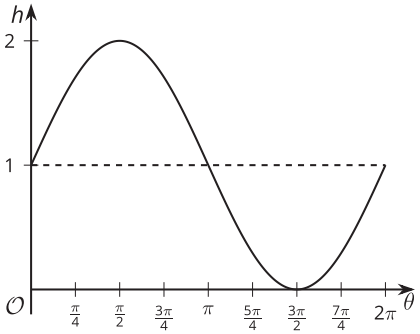
## Lesson 14 Summary

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.



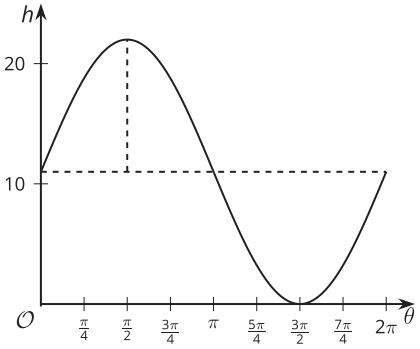

The graph of the height of $P$ looks just like the graph of the sine function but it has been raised by 1 unit:

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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