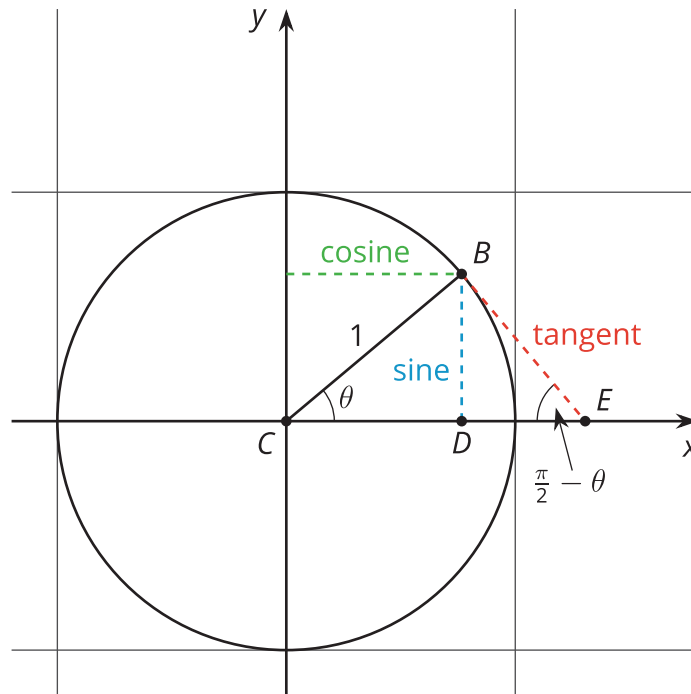


# Some New Ratios

Let's explore graphs of some more trigonometric functions.

## 13.1 Notice and Wonder: Angles and Lines

What do you notice? What do you wonder?



## 13.2 Some Additional Lines

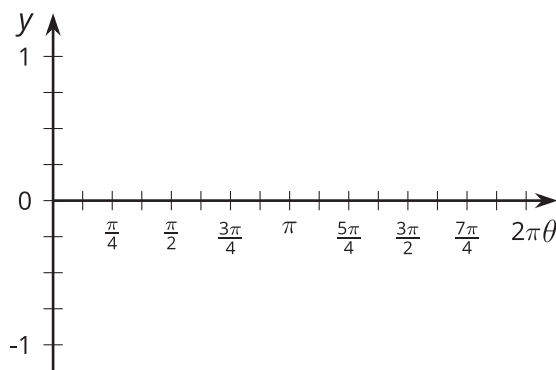
Your teacher will assign you a function—either secant, or cotangent, where  $f(\theta) = \sec(\theta)$ ,  $g(\theta) = \csc(\theta)$ , and  $h(\theta) = \cot(\theta)$ .

- Complete the table of values for your function from 0 to  $2\pi$ .

| $\theta$         |  |
|------------------|--|
| 0                |  |
| $\frac{\pi}{6}$  |  |
| $\frac{\pi}{4}$  |  |
| $\frac{\pi}{3}$  |  |
| $\frac{\pi}{2}$  |  |
| $\frac{2\pi}{3}$ |  |
| $\frac{3\pi}{4}$ |  |
| $\frac{5\pi}{6}$ |  |
| $\pi$            |  |

| $\theta$          |  |
|-------------------|--|
| $\frac{7\pi}{6}$  |  |
| $\frac{5\pi}{4}$  |  |
| $\frac{4\pi}{3}$  |  |
| $\frac{3\pi}{2}$  |  |
| $\frac{5\pi}{3}$  |  |
| $\frac{7\pi}{4}$  |  |
| $\frac{11\pi}{6}$ |  |
| $2\pi$            |  |

- Graph your function from 0 to  $2\pi$ .



- Create a display that includes your function name, the graph, the trigonometric ratio, and the reciprocal identity.



### Are you ready for more?

The “co” in “cosine,” “cotangent,” and “cosecant” refers to the complement of the angle. The complement of  $\theta$  is  $\frac{\pi}{2} - \theta$ .

Explain for each of the function pairs how you know that the statements are true:

1.  $\cos(\theta) = \sin\left(\frac{\pi}{2} - \theta\right)$

2.  $\cot(\theta) = \tan\left(\frac{\pi}{2} - \theta\right)$

3.  $\csc(\theta) = \sec\left(\frac{\pi}{2} - \theta\right)$

## 13.3 Card Sort: Periodic Functions

Your teacher will give you a set of cards. Take turns with your partner to match a graph with a function name, ratio, and identity.

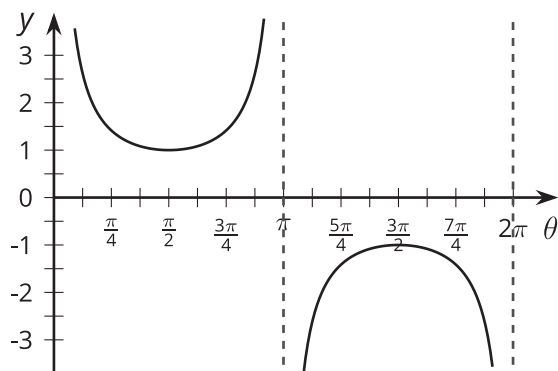
1. For each match that you find, explain to your partner how you know it's a match.
2. For each match that your partner finds, listen carefully to the explanation. If you disagree, discuss your thinking, and work to reach an agreement.

## Lesson 13 Summary

We can use the sine, cosine, and tangent functions to talk about some new trigonometric functions: cosecant, secant, and cotangent.

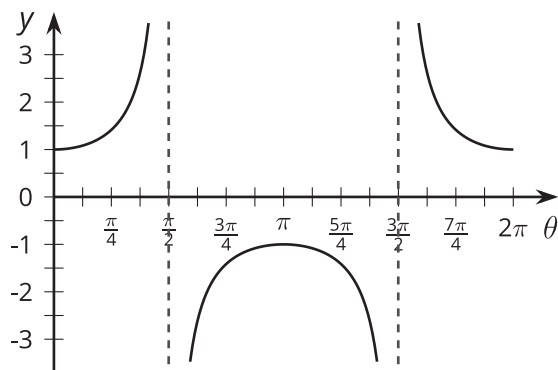
*Cosecant* is the reciprocal function of sine. This means that  $\csc(\theta) = \frac{1}{\sin(\theta)}$ . On a right triangle, we can identify the trigonometric ratio  $\csc(\theta) = \frac{\text{hypotenuse}}{\text{opposite}}$ . We can use this information to create a graph of  $y = \csc(\theta)$ . The graph will have an asymptote any time  $\sin(\theta) = 0$ . We also know that  $y = 1$  any time  $\sin(\theta) = 1$ ,  $y = -1$  any time  $\sin(\theta) = -1$ , and has the same period as  $\sin(\theta)$ . Here is the graph of  $y = \csc(\theta)$ :

$$y = \csc(\theta)$$



*Secant* is the reciprocal function of cosine. This means that  $\sec(\theta) = \frac{1}{\cos(\theta)}$ . On a right triangle, we can identify the trigonometric ratio  $\sec(\theta) = \frac{\text{hypotenuse}}{\text{adjacent}}$ . We can use this information to create a graph of  $y = \sec(\theta)$ . The graph will have an asymptote any time  $\cos(\theta) = 0$ . We also know that  $y = 1$  any time  $\cos(\theta) = 1$ ,  $y = -1$  any time  $\cos(\theta) = -1$ , and has the same period as  $\cos(\theta)$ . Here is the graph of  $y = \sec(\theta)$ :

$$y = \sec(\theta)$$



*Cotangent* is the reciprocal function of tangent. This means that  $\cot(\theta) = \frac{1}{\tan(\theta)}$ . On a right triangle, we can identify the trigonometric ratio  $\cot(\theta) = \frac{\text{adjacent}}{\text{opposite}}$ . We can use this information to create a graph of  $y = \cot(\theta)$ . The the graph will have an asymptote any time  $\tan(\theta) = 0$ , and it will have a value of 0 any time  $\tan(\theta)$  has an asymptote. We also know that  $y = 1$  any time  $\tan(\theta) = 1$ ,  $y = -1$  any time  $\tan(\theta) = -1$ , and has the same period as  $\tan(\theta)$ . Here is the graph of  $y = \cot(\theta)$ :

$y = \cot(\theta)$

