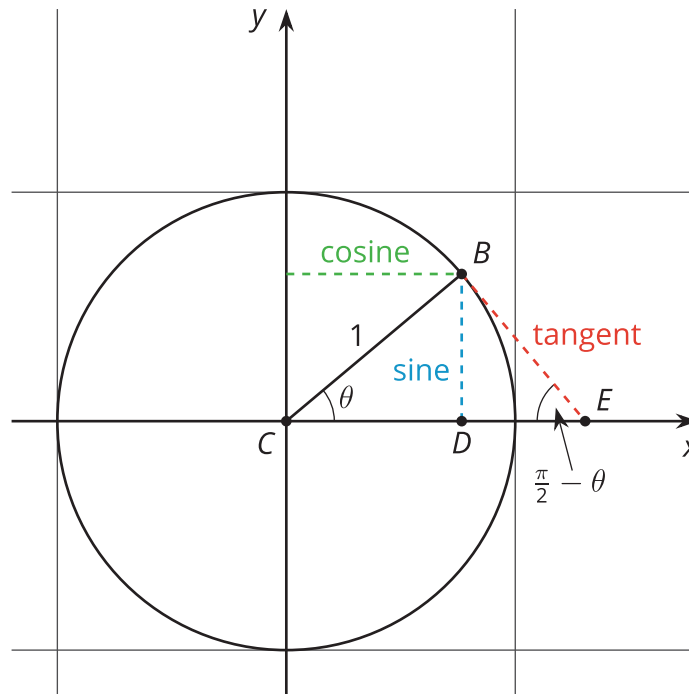# Some New Ratios

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?
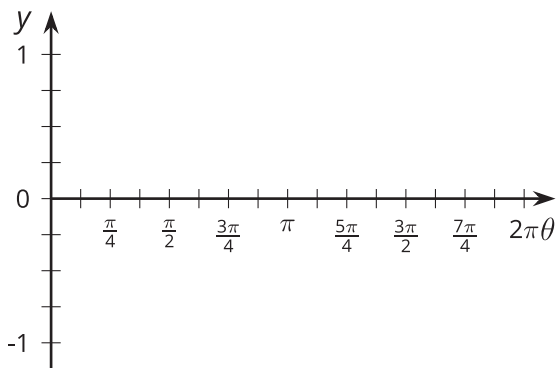
13.2 Some Additional Lines

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

1. Complete the table of values for your function from 0 to 2π.

θ	
0	
$\frac{\pi}{6}$	
$\frac{\pi}{4}$	
$\frac{\pi}{3}$	
$\frac{\pi}{2}$	
$\frac{2\pi}{3}$	
$\frac{3\pi}{4}$	
$\frac{5\pi}{6}$	
π	

θ	
$\frac{7\pi}{6}$	
$\frac{5\pi}{4}$	
$\frac{4\pi}{3}$	
$\frac{3\pi}{2}$	
$\frac{5\pi}{3}$	
$\frac{7\pi}{4}$	
$\frac{11\pi}{6}$	
2π	

2. Graph your function from 0 to 2π.

3. 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 θ is $\frac{\pi}{2} - \theta$.

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

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

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

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

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.
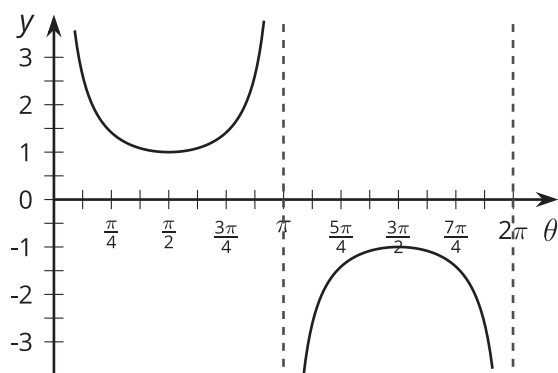
1. For each match that you find, explain to your partner how you know it's a match.

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.
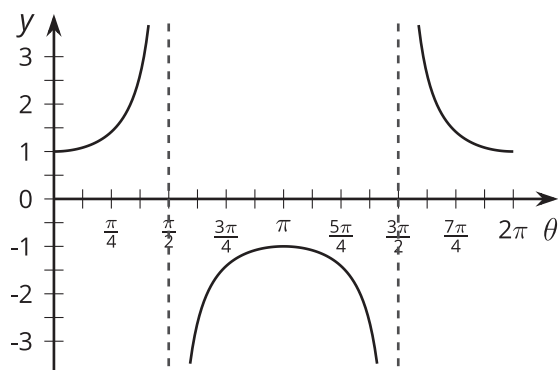
Cosecant is the reciprocal function of sine. This means that $\csc(\theta) = \frac{1}{\sin(\theta)}$. On a right triangle, we can identify the trigonometric ratio $\csc(\theta) = \frac{\text{hypotenuse}}{\text{opposite}}$. We can use this information to create a graph of $y = \csc(\theta)$. The graph 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 $y = \cot(\theta)$:

$y = \cot(\theta)$