

9.2

Angles and Radian Measure

What You Will Learn

- ▶ Draw angles in standard position.
- ▶ Find coterminal angles.
- ▶ Use radian measure.

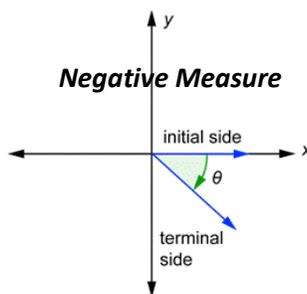
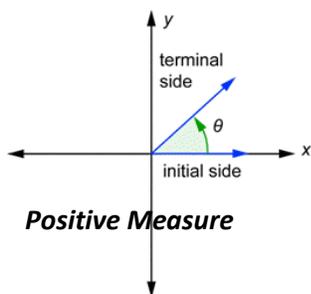
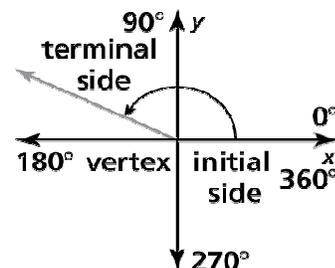
Drawing Angles in Standard Position

In this lesson, you will expand your study of angles to include angles with measures that can be any real numbers.

Angles in Standard Position

In a coordinate plane, an angle can be formed by fixing one ray, called the **initial side**, and rotating the other ray, called the **terminal side**, about the vertex.

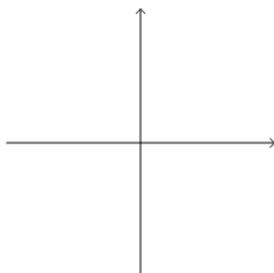
An angle is in **standard position** when its vertex is at the origin and its initial side lies on the positive x -axis.



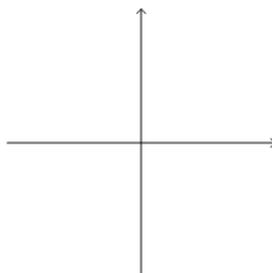
is positive when the rotation is counterclockwise and negative when it is clockwise. The angle can rotate more than 360° .

Example: **Drawing Angles in Standard Position** - Draw an angle with the given measure in standard position.

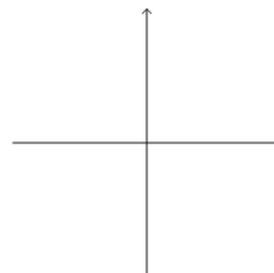
a. 240°



b. 500°



c. -50°

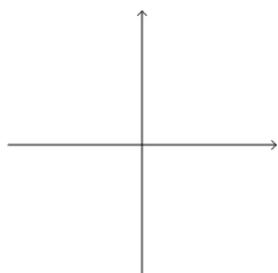


Finding Coterminal Angles

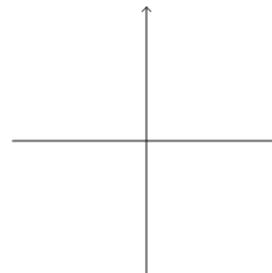
In Example 1(b), the angles 500° and 140° are **coterminal** because their terminal sides coincide. An angle coterminal with a given angle can be found by adding or subtracting multiples of 360° .

Example: **Finding Coterminal Angles** - Find one positive angle and one negative angle that are coterminal with

(a) -45°



(b) 395°



Find one positive angle and one negative angle that are coterminal with the given angle.

5. 80°

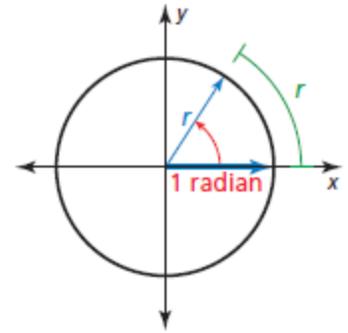
6. 230°

7. 740°

8. -135°

Using Radian Measure

Angles can also be measured in *radians*. To define a radian, consider a circle with radius r centered at the origin, as shown. One **radian** is the measure of an angle in standard position whose terminal side intercepts an arc of length r .



Because the circumference of a circle is $2\pi r$, there are 2π radians in a full circle. So, degree measure and radian measure are related by the equation $360^\circ = 2\pi$ radians, or $180^\circ = \pi$ radians.

Converting Between Degrees and Radians

Degrees to radians

Multiply degree measure by

$$\frac{\pi \text{ radians}}{180^\circ}$$

Radians to degrees

Multiply radian measure by

$$\frac{180^\circ}{\pi \text{ radians}}$$

Examples

$$60^\circ$$

$$\frac{\pi}{6}$$

Example: **Convert Between Degrees and Radians** - Convert the degree measure to radians or the radian measure to degrees.

a. 120°

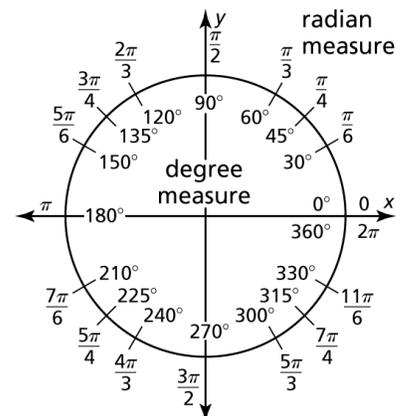
b. $-\frac{\pi}{12}$

Degree and Radian Measures of Special Angles

The diagram shows equivalent degree and radian measures for special angles from 0° to 360° (0 radians to 2π radians).

You will find it necessary to memorize the equivalent degree and radian measures of special angles in the first quadrant

and for $90^\circ = \frac{\pi}{2}$ radians. All other special angles shown are multiples of these angles.



Example: **Convert the degree measure to radians or the radian measure to degrees.**

a. 135°

b. -40°

c. $5\pi/4$