

# Radians

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A radian is defined as the length of a circular arc that is equal to the radius of the circle.

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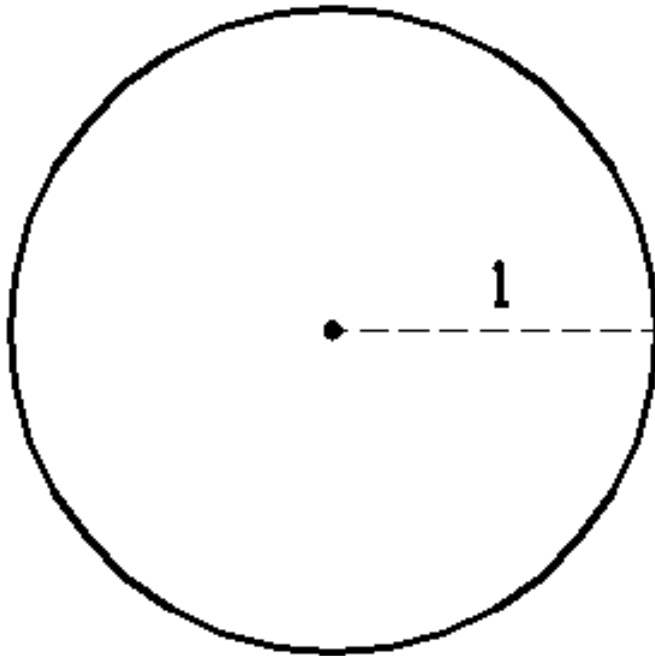
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If we choose a circle with a radius of 1, the circle is referred to as a *unit circle*.

If a central angle of the unit circle intercepts an arc with length 1 then the measure of the central angle is 1 radian.

So, we can use arc length to measure angles.

# Arc Length on a Unit Circle



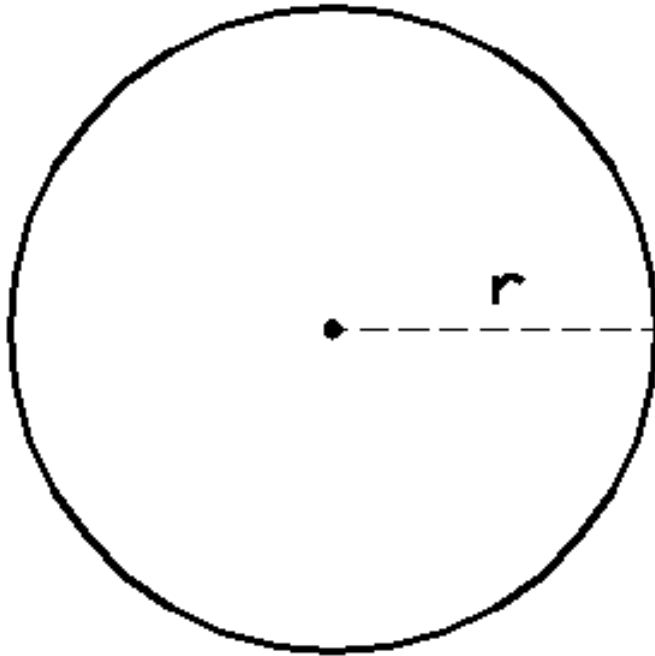
If you walked along the arc of this circle, one complete revolution, you would have walked a distance of  $2\pi$  units.

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# Why?



For any circle of  
radius  $r$ :  $c = 2 \pi r$

so in a circle with  
radius 1

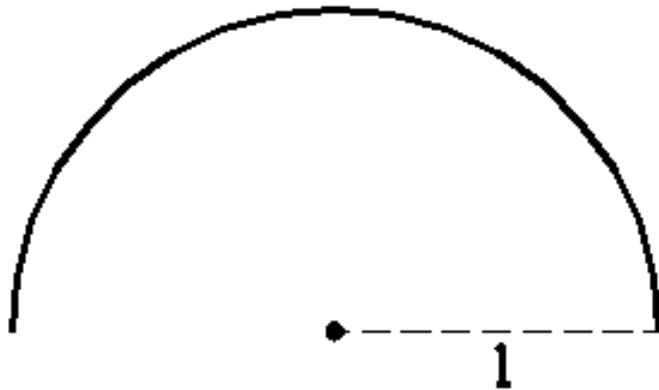
$$\begin{aligned} c &= 2 \pi (1) \\ &= 2 \pi \end{aligned}$$

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How far would one travel if they walked half way around the unit circle?



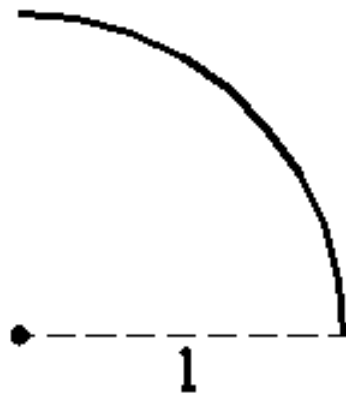
$$\begin{aligned}\text{Distance} &= \frac{2\pi}{2} \text{ units} \\ &= \pi \text{ units}\end{aligned}$$

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How far would one travel if they walked one-quarter the distance around the unit circle?



$$\begin{aligned}\text{Distance} &= \frac{2\pi}{4} \text{ units} \\ &= \frac{\pi}{2} \text{ units}\end{aligned}$$

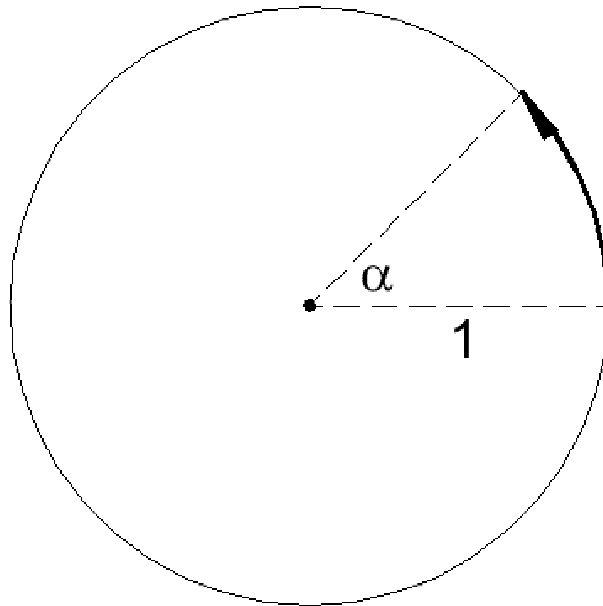
What does the distance traveled along the arc of a unit circle have to do with radians?

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The radian system of measurement is based on using arc length:  $\alpha$  is the distance traveled along the arc of a unit circle.



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This means that if the central angle measures  $90^\circ$ , this angle is equivalent to  $\frac{\pi}{2}$  radians.

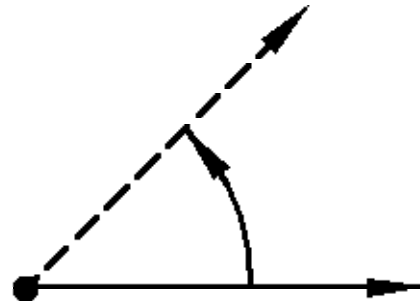
To illustrate . . .

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$$90^\circ \approx \frac{\pi}{2} \text{ radians}$$



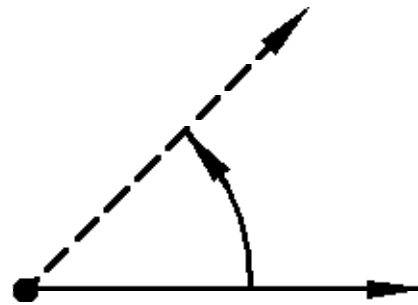
$\frac{1}{4}$  revolution ccw

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



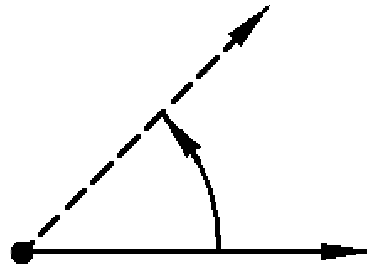
$\frac{1}{2}$  revolution ccw

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$$270^\circ \approx \frac{3\pi}{2} \text{ radians}$$



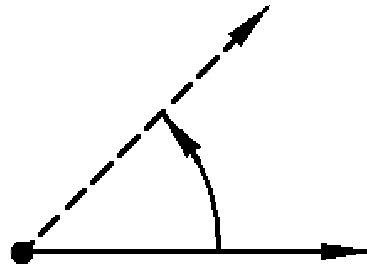
$\frac{3}{4}$  revolution ccw

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$$360^\circ \approx 2\pi \text{ radians}$$



one revolution ccw

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If one were to complete two revolutions ccw, what would this measure in radians?

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$$360^\circ + 360^\circ = 720^\circ$$

which is equivalent to

$$2\pi + 2\pi = 4\pi$$

$2\pi \cdot n$  gives the radian measurement for  $n$  complete counter-clockwise revolutions.

What if we walked along the arc of a unit circle clockwise instead of counterclockwise?

We simply insert a negative sign to indicate movement in the clockwise direction, as with degrees.

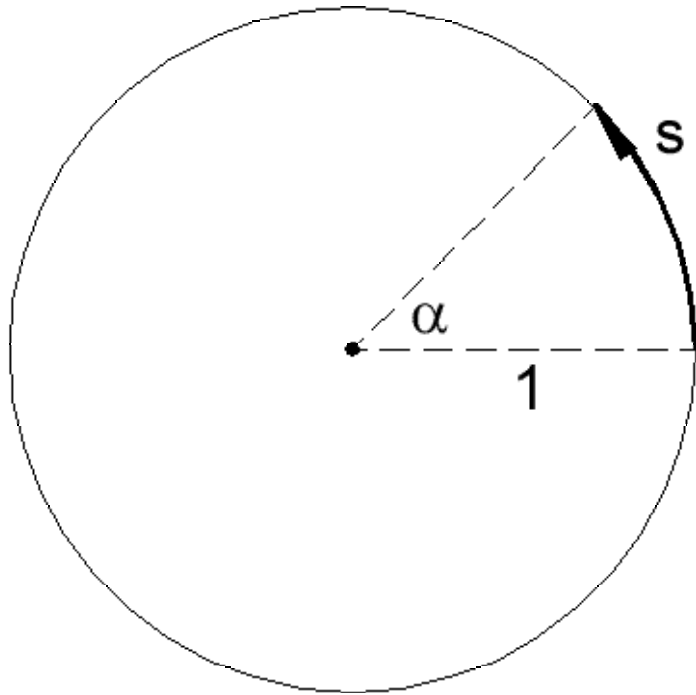
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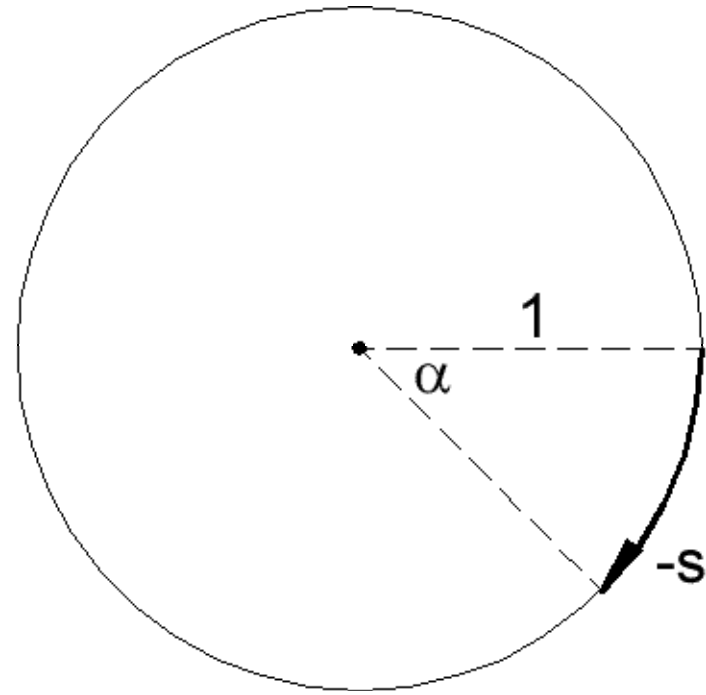
# Pictures to remember

Revolve ccw



$$m(\alpha) = s$$

Revolve cw



$$m(\alpha) = -s$$

$s$  = measure of arc length

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# End of Radians

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