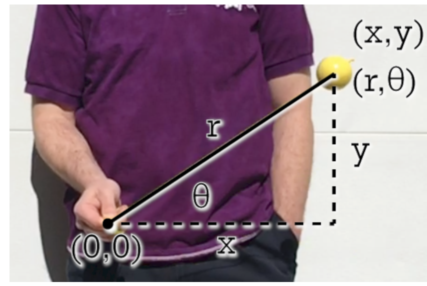
Flipping Physics Lecture Notes:

Introduction to Circular Motion and Arc Length

Circular Motion simply takes what you have learned before and applies it to objects which are moving along a circular path. Let's begin with a drawing of an object which is moving along a circle with a constant radius. We have paused the object at one point in time to discuss how we identify the location of an object which is moving along a circle.

The x-y coordinate system which locates an object in two or three dimensional space relative to an origin was introduced by René Descartes in the 1600s. When we identify the location of an object which is moving along a circle using Cartesian coordinates, notice that both the x and y position values of the object change as a function of time. We can also identify the objects location using polar coordinates which use the radius and angular position to identify the location of the object.



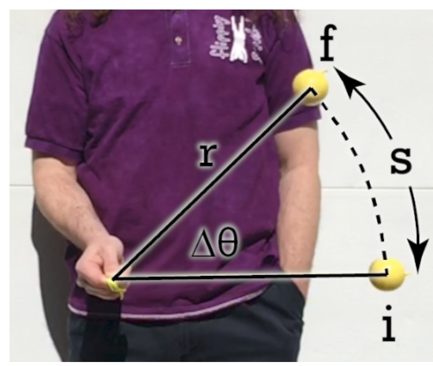

Notice when we use radius and angular position to identify the location of an object moving along a circle, the angular position changes, however, the radius stays constant. Having only one variable change as a function of time while describing the location of an object is much easier to work with than when two variables change.

We can relate Cartesian and polar coordinates using trig functions:

$$\sin\theta = \frac{O}{H} = \frac{y}{r} \Rightarrow y = r\sin\theta \quad \& \quad \cos\theta = \frac{A}{H} = \frac{x}{r} \Rightarrow x = r\cos\theta$$

Now let's discuss how we describe an object moving from one location to another when it is moving along a circle with a constant radius. In the drawing the object has moved from the initial position to the final position while moving through an angular displacement:

$$\Delta\theta = \theta_f - \theta_i$$




Arc Length:

- The linear distance traveled when an object is moving along a curve.
- The symbol for arc length is s.
- The equation for arc length is $s = r\Delta\theta$
- You must use radians for the angular displacement in the arc length equation.
  - We will demonstrate why soon in a future video.
- The arc length when an object moves through a full circle is called Circumference.
  - The angular displacement when an object moves through a full circle is $2\pi$ radians.
  - The equation for circumference is $C = 2\pi r = r(2\pi)$, which you can see is a special case of the equation for arc length when the angular displacement is one revolution.