Rotational kinematics
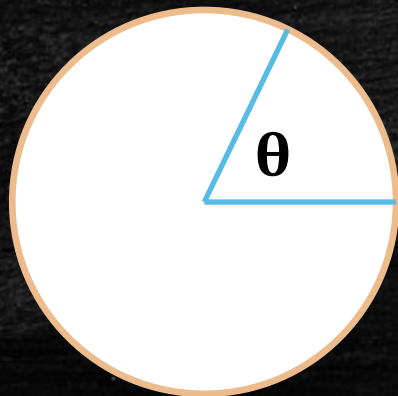
Fundamental definition

- Rotation (for this class) will consider motion on a circular path where the speeds may be changing in time.

- Can measure angular position in three different units:

$$1 \text{ revolution} = 360° = 2\pi \text{ radians}$$

- Fundamental relationship for a circle:

$$s = \theta r$$

for $\theta = 2\pi$ we have:

$$s = 2\pi r = \text{circumference}$$

Kinematic variables

- Rotational kinematics is extremely similar to linear kinematics.
- In fact, we can use the old equation and change the names of the variables.

	linear motion	rotational motion
Distance:	x	θ
Velocity:	v	ω
Acceleration:	a	α

Linear to rotational conversions

- We can convert between linear and rotational quantities using the following definitions:

Distance & angle: $s = \theta r$

Velocity & angular velocity: $v = \omega r$

Acceleration & angular acceleration: $a = \alpha r$

Introduction

Linear equations

$$x = x_0 + v_0 t + \tfrac{1}{2} a t^2$$

$$v = v_0 + at$$

$$x = x_0 + \tfrac{1}{2}(v_0 + v)t$$

$$v^2 = v_0^2 + 2a(x - x_0)$$

Rotational equations

$$\theta = \theta_0 + \omega_0 t + \tfrac{1}{2} \alpha t^2$$

$$\omega = \omega_0 + \alpha t$$

$$\theta = \theta_0 + \tfrac{1}{2}(\omega_0 + \omega)$$

$$\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$$

Part 1: kinematics, Problem #1

- We know that our star, Sun, sits at a distance of about 2.5×10^{17} km from the center of the Milky Way galaxy. If we are moving with a speed of about 220 km/s, how long (in years) does it take for us to orbit the galaxy once?

Part 1: kinematics, Problem #2

- A discus thrower wants to achieve a throw speed of 24.5 m/s. If the distance from the center of rotation to the discus is 1.20 m, what angular acceleration is needed to launch the discus after 1.5 revolutions?