Theme Music: Mary Chapin Carpenter

Down at the Twist and Shout

Cartoon: Mort & Greg Walker

Beetle Bailey
Outline

■ Recap of forces in circular motion
■ Rotational Kinematics
  – angles (radians)
  – angular velocity and angular acceleration
  – trig for large angles
■ Thinking about balance:
  The Rotational Effect of Forces
Uniform Circular Motion

Position

Velocity

Acceleration

\[
\frac{v \Delta t}{R} = \frac{a \Delta t}{v}
\]

\[
\frac{a}{v} = \frac{v}{R}
\]

\[
a = \frac{v^2}{R}
\]
Uniform Circular Motion: Forces

\[ \vec{a} = \frac{\vec{F}^{\text{net}}}{m} \]

always

\[ \vec{a} = -\frac{v^2}{R} \hat{r} \]

in order for the object to move in a circle with constant speed.

\[ \frac{\vec{F}^{\text{net}}}{m} = -\frac{v^2}{R} \hat{r} \]

Therefore, to do this, we need a net force.

\[ \vec{F}^{\text{net}} = -\frac{mv^2}{R} \hat{r} \]
Radian

The radian is an angle measure defined as the ratio of the arc length of the circle spanned by the angle to the radius of the circle.

\[ \theta = \frac{L}{R} \quad \text{(in radians)} \]

\[ \theta_{\text{whole circle}} = \frac{2\pi R}{R} = 2\pi \]

\[ \frac{\theta_{\text{rad}}}{\theta_{\text{deg}}} = \frac{2\pi}{360} \]
Rotational Kinematics: Polar Description of Motion

- Describing the angular position of an object.
  - Angle (radians) $\theta$
  - Angular velocity $\omega$
  - Angular acceleration $\alpha$

\[ \theta \text{ (in radians)} = \frac{2\pi}{360} \theta \text{ (in degrees)} \]

\[ \langle \omega \rangle = \frac{\Delta \theta}{\Delta t}, \quad \langle \alpha \rangle = \frac{\Delta \omega}{\Delta t} \]

Uniform motion: $\Delta \theta = \omega_0 \Delta t$
Trigonometry for big angles

\[ \vec{r} = xi + yj = (R \cos \theta)\hat{i} + (R \sin \theta)\hat{j} \]
\[ \theta = \theta_0 + \omega_0(t - t_0) \]

What happens as \( t \) (and \( \theta \)) gets large (bigger than \( 2\pi \))?