Uniform Circular Motion

Object moves on a circle at constant speed.

Direction changes at every instant!

\[ v_1 = v_2 \]

\[ v_1 \neq v_2 \]
Uniform Circular Motion

\[
a = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t} \text{ here } a_R: \text{ radial acc.}
\]

\[
\Delta v / v = \Delta l / r \implies \Delta v = \Delta l \frac{v}{r}
\]

\[
a_R = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t} = \lim_{\Delta t \to 0} (\frac{v}{r} \frac{\Delta l}{\Delta t})
\]

But \[\lim_{\Delta t \to 0} \frac{\Delta l}{\Delta t} = v \implies a_R = \frac{v^2}{r}\]
Uniform Circular Motion

Acceleration $a$ is always perpendicular to velocity.

\[ T = \frac{1}{f} \]

\[ \mathbf{v} = \frac{2\pi r}{T} \]
Dynamics of Circular Motion

\[ a_R = \frac{v^2}{r} \implies F_R = ma_R = m \frac{v^2}{r} \]
Dynamics of Circular Motion

Force Diagram: Centripetal force
Newton's 3rd law: Force on your hand

Centrifugal force does not exist!
Unbanked vs. Banked Curves

(a) $F_N$  
(b) $F_N$ 

$F_G = mg$

Calculate Banked Curve Problem