

# **Circular Motion and Universal Law of Gravitation**

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# Summary: Circular Motion

- arc length  $s = R\theta$
- tangential velocity  $v = \frac{ds}{dt} = R \frac{d\theta}{dt} = R\omega$
- tangential acceleration  $a_{\theta} = \frac{dv_{\theta}}{dt} = R \frac{d^2\theta}{dt^2} = R\alpha$
- centripetal acceleration  $|a_r| = v\omega = \frac{v^2}{R} = R\omega^2$

# Circular Motion Vector Description

- Use plane polar coordinates

- Position  $\vec{\mathbf{r}}(t) = R\hat{\mathbf{r}}(t)$

- Velocity  $\vec{\mathbf{v}}(t) = R\frac{d\theta}{dt}\hat{\boldsymbol{\theta}}(t) = R\omega\hat{\boldsymbol{\theta}}(t)$

$$\vec{\mathbf{a}} = a_r\hat{\mathbf{r}} + a_\theta\hat{\boldsymbol{\theta}}$$

- Acceleration

$$a_\theta = r\alpha$$

$$a_r = -r\omega^2 = -(v^2 / r)$$