

Rotational Motion

- If an object keeps a fixed distance around a rotational axis (travels in circle) can describe its position by an angle $\theta(t)$
- Just like linear position, can define its derivatives
 - Angular velocity: $\omega = d\theta/dt$
 - Angular acceleration: $\alpha = d\omega/dt = d^2\theta/dt^2$
- Rigid objects: every part has same ω , α

Constant Acceleration Kinematics

- Math for angles is the same as for straight lines if (angular) acceleration constant

$$\omega_f = \omega_i + \alpha t$$

$$\Delta \theta = \omega_i t + \frac{1}{2} \alpha t^2$$

$$\omega_f^2 = \omega_i^2 + 2 \alpha \Delta \theta$$

Angular Units

- Common units for angles:
 - Radians (rad)
 - Revolutions (one full time around, $1 \text{ rev} = 2\pi \text{ rad}$)
 - Degrees ($180 \text{ deg} = \pi \text{ rad}$)

Relationships Between Linear and Angular Variables

- For object traveling in a circle:
 - Distance/arc length: $s = r\theta$
 - Speed rel. to center: $v = r\omega$
 - Magnitude of accel. rel. to center: $a = r\alpha$

Relationships Between Linear and Angular Variables

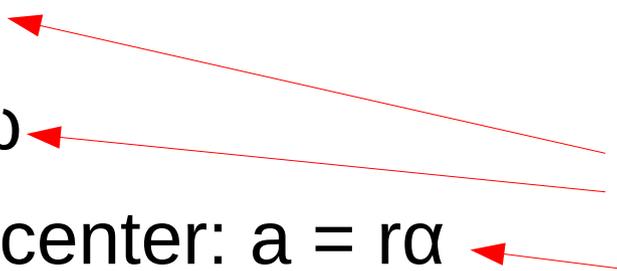
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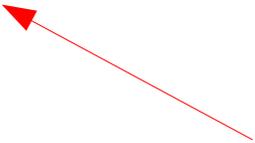
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All must be
In rad!



Rolling Objects

- Rolling objects: object travels same distance as arc length around
- Also: $v_{cm} = R\omega$



Speed of center rel. to ground as it rolls,
but same equation as speed of piece as it goes around
center!

Torque

- Forces applied to an object not through center of mass make it want to rotate (give angular accel.)
- Magnitude of torque about a certain axis:

$$\tau = |\vec{r} \times \vec{F}| = r F \sin \phi$$

Distance of location of applied force from chosen axis

Angle between direction of force and direction from center to location of force

- Yes, torque and the cross product produce vectors with direction (more review Monday)