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 rev = 2π rad)
  - Degrees (180 deg = π 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: $a = r\alpha$

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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)