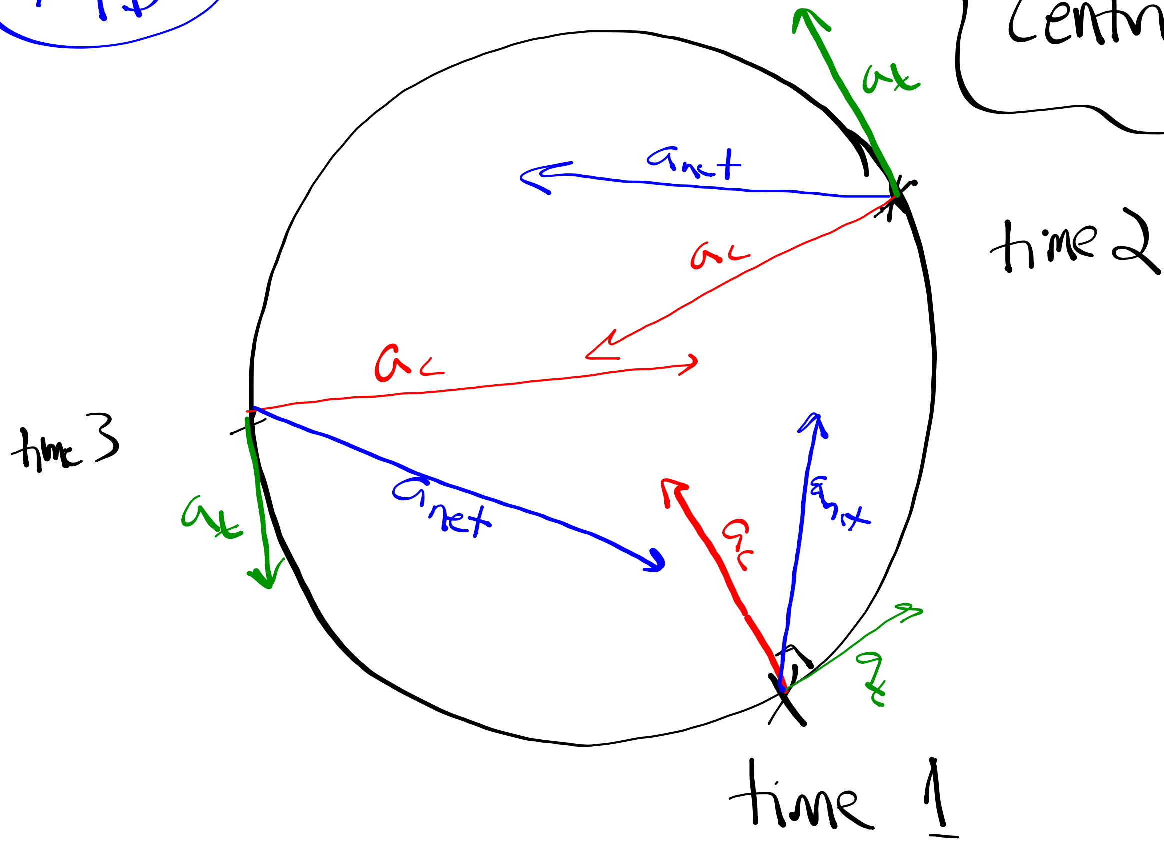
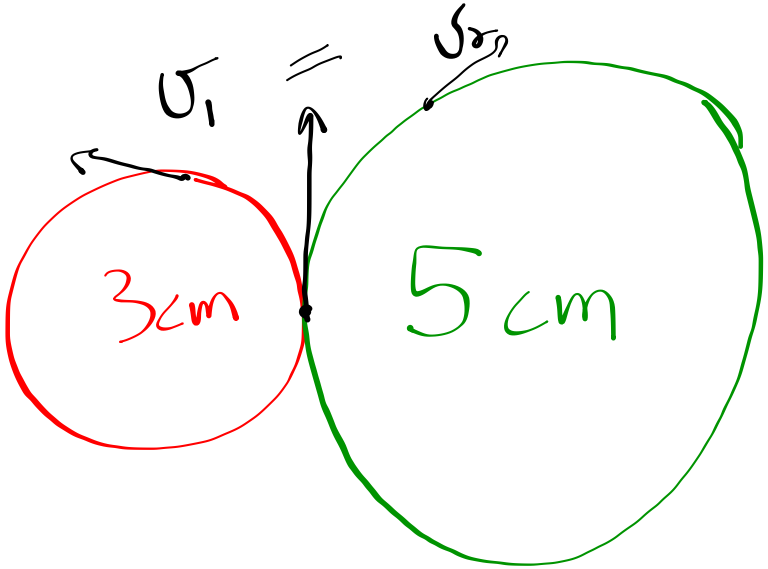
14b

"radial" acceleration = centripetal acceleration



$$a_c = \frac{v^2}{r}$$

18



$v_1 = v_2 = v$

(when two wheels are in contact)

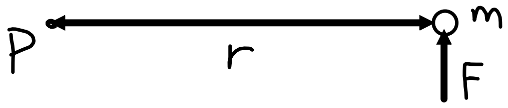
Mass is the characteristic of an object that resists acceleration; if a net force is applied, an object accelerates:

$$\Sigma F = ma$$

The larger the mass, the smaller the acceleration will be.

The larger the mass, the more resistance the object has to being accelerated.

Consider a mass *m* constrained to remain *r* meters away from a center of rotation at point P.



If F is applied at *m*, *m* will accelerate upward.

$$\Sigma F = ma$$
$$F = ma$$

$$\alpha = \frac{a_t}{r}$$

m experiences α about the axis of rotation at P

$$a = \alpha r$$
$$\therefore F = ma = m(\alpha r) = mr\alpha$$
$$\therefore F = mr\alpha$$

Forces must exert torques if there is to be rotation.

$$\tau = F \cdot r$$
$$= (mr\alpha)\, r$$
$$\tau = mr^2\alpha$$

$\Sigma\tau = (mr^2)\alpha$ Generalized for a sum of applied torques.

$\boxed{\Sigma\tau = I\alpha}$ Here we define a new quantity -- I

Moment of Inertia
"Angular mass"

Newton's 2nd Law

$$\sum \tau = I \alpha$$

For rotating systems

Moment of Inertia = resistance to changes in rotation

$$\sum F = m a$$

For translating (linear) systems

α, a: Resulting acceleraton

I, m: Resistance to Acceleration

$\sum \tau$, $\sum F$: Net / Total Applied Force/Torque

MOMENT OF INERTIA

$$\Sigma \tau = I\alpha$$

I = MOMENT OF INERTIA

I IS DEPENDENT UPON:

- THE OBJECT'S DISTRIBUTION OF MASS
- THE LOCATION OF THE AXIS OF ROTATION

UNITS OF I:

$kg \cdot m^2$ OR $slug \cdot ft^2$

$$I_{\text{POINT MASS}} = mr^2$$

(sum for multiple points)

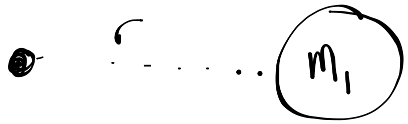
IN SUMMARY:

I_{system} = the sum of all of the I's of all of the parts

I depends upon not just mass, but its distance from the axis of rotation

I depends upon the location of the axis of rotation

I is object dependent

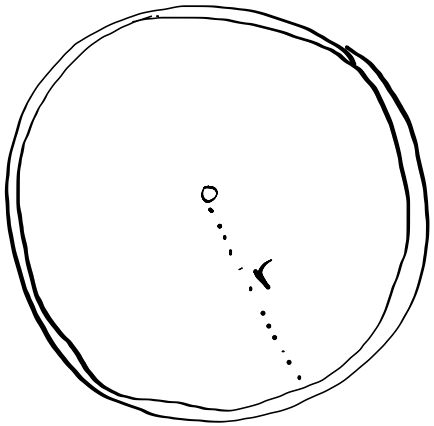


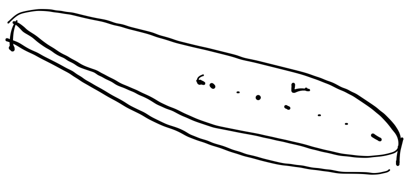
$I_{point\ mass} = mr^2$

$I_{hoop} = mr^2$ (rotating about its center like a wheel)

$I_{disk} = 1/2mr^2$ (rotating about its center like a wheel)

The moments of inertias you will need to know; all others will be provided, or you will solve for.





Many objects enjoy symmetry and uniformity and as a result, there moments of inertias can be expressed in terms of their masses, radii, lengths, and other basic parameters.

Note: you always must pay attention to where the axis of rotation is! These relations always apply to a specific location for the axis of rotation!

This link will take you to a table of moments of inertias for various objects:

http://www.livephysics.com/physical-constants/mechanics-pc/moment-inertia-uniform-objects/

So what do you do to determine the moment of inertia of an object that isn't "nice" (i.e. one that doesn't enjoy symmetry or uniformity and therefore doesn't have a simple equation for its moment of inertia?)

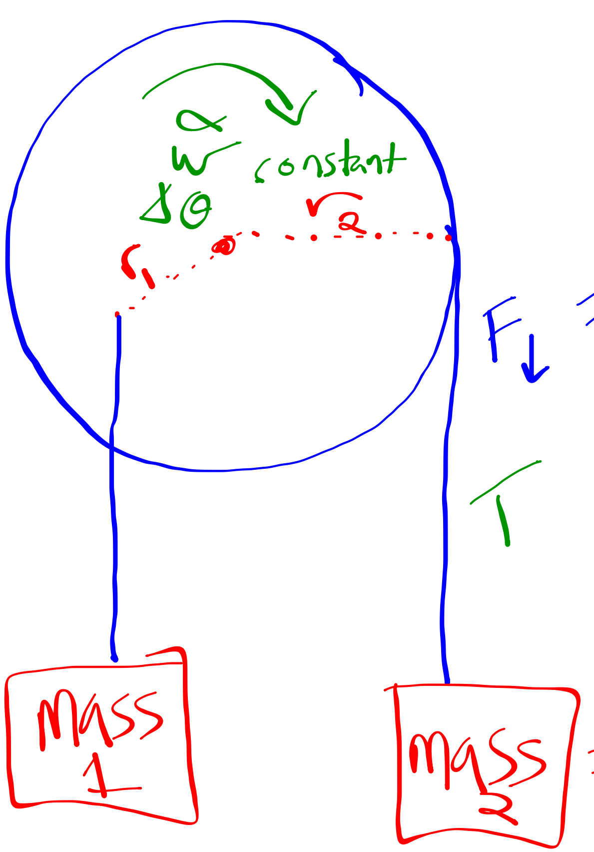
$$\frac{\Sigma\tau}{\alpha} = \frac{I\alpha}{\alpha}$$

$$I = \frac{\Sigma\tau}{\alpha}$$

$\tau = F \cdot r$ ✓

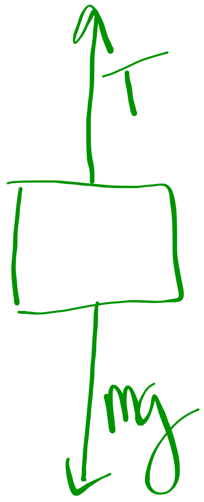
$$\frac{\Delta\omega}{\Delta t}$$

Big 3 angular Kinematics



= mg

$F_\downarrow \neq mg$ (necessarily)



$T = mg$ if $a = 0$ ONLY

if $a \neq 0$

$T - mg = ma$