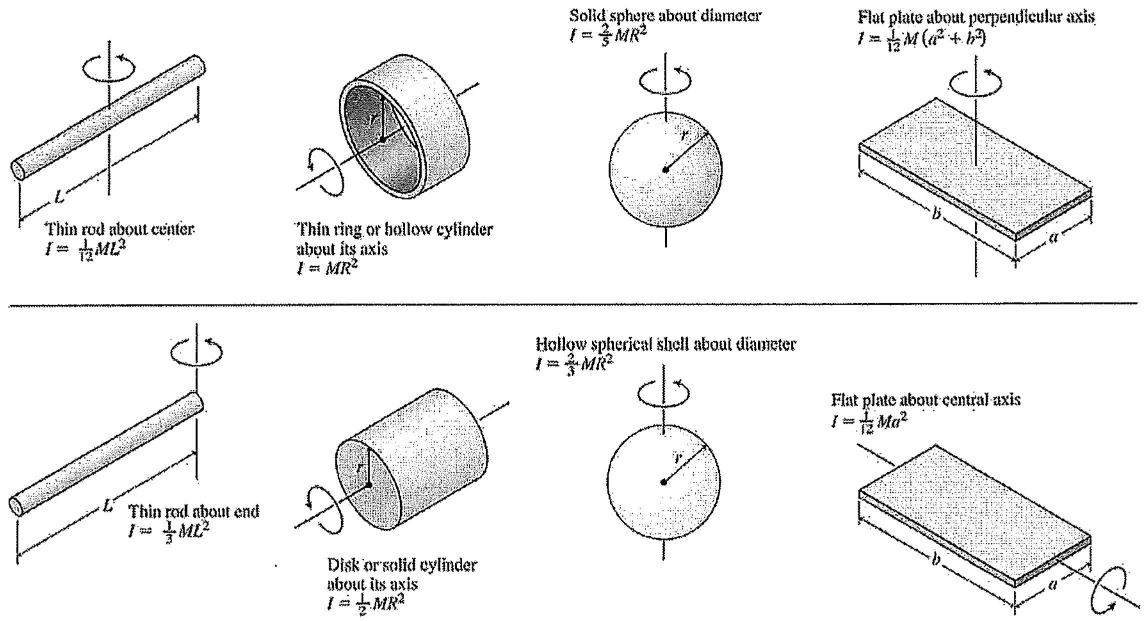
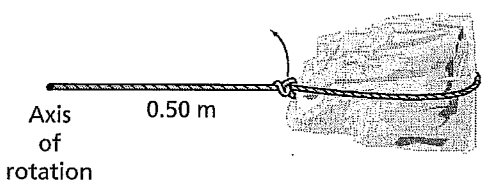
M2

Rotational Dynamics

Point Mass : $I = mr^2$



A 0.50-m length of string with a 0.20-kg weight at one end is rotated around the other end, as shown in the diagram.



Assuming the mass of the string is zero and the weight is a point mass, what is the moment of inertia of the weight?

A $0.020\ kg \cdot m^2$

B $0.050\ kg \cdot m^2$

C $0.10\ kg \cdot m^2$

D $0.50\ kg \cdot m^2$

A solid sphere with a radius of 0.050 m and a mass of 3.0 kg has a rod through its center. A net torque of $6.0 \times 10^{-4}\ kg \cdot m^2$ is used to spin the sphere about the rod. What is the sphere's angular acceleration? *Hint: The moment of inertia for the sphere is* $\frac{2}{5}mr^2$.

A $0.20\ rad/s^2$

B $0.21\ rad/s^2$

C $2.5\ rad/s^2$

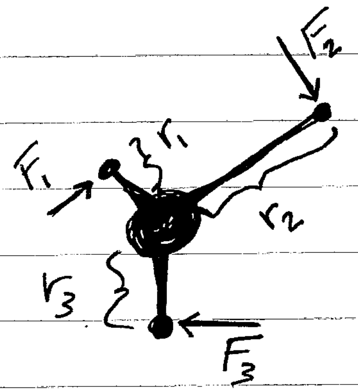
D $5.0\ rad/s^2$

$\Sigma\tau = I\alpha$

$\Sigma\tau = r_\perp \cdot F$

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

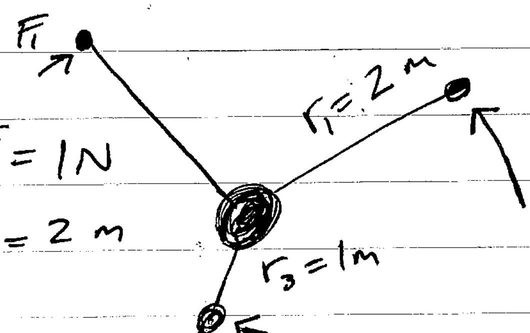
$I = 20\ kgm^2$



$F_1 = .2\ N$
$F_2 = .4\ N$
$F_3 = .6\ N$
$r_1 = .1\ m$
$r_2 = .3\ m$
$r_3 = .2\ m$

A.) An object with moment of inertia is acted upon by three torques.

1. What is the $\Sigma \tau$?
2. What is α?



$F_1 = 1N$

$r_2 = 2\ m$

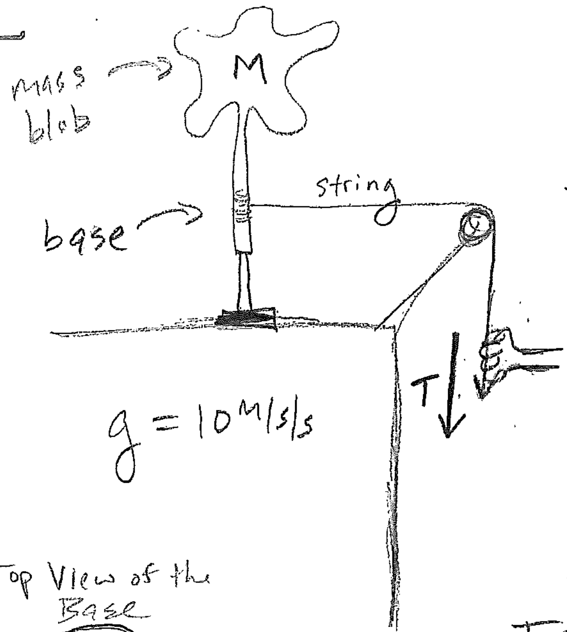
$I = .25\ kgm^2$

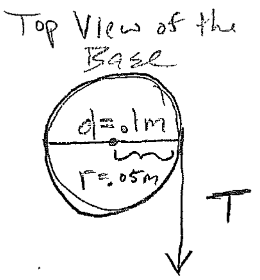
$F_3 = 3N$

B.) r_1 1. What is the $\Sigma \tau$?

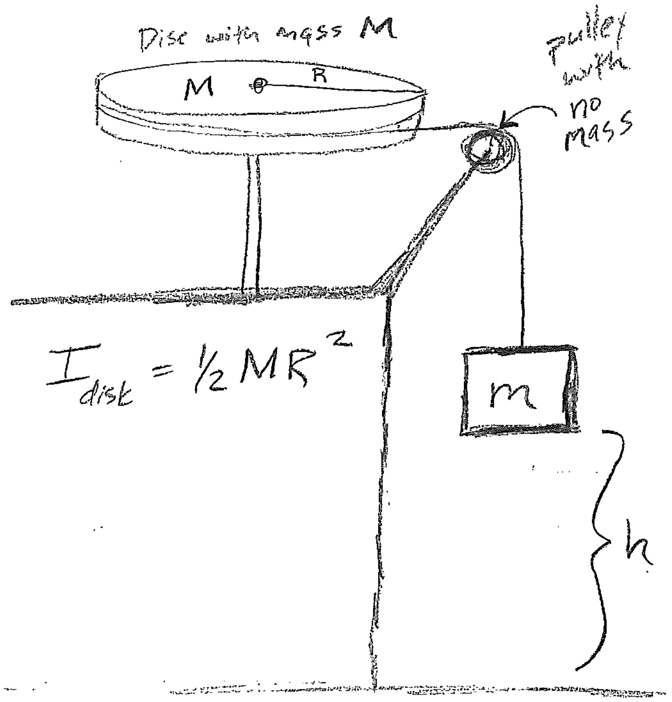
2. What is the α?

1. A 75 kg grinding disc ($I = \frac{1}{2}mr^2$) has radius $r = .28$ m. A force of 180 N is applied tangentially counter clockwise to the disk. What is the torque?
2. What is the resulting α?
3. If an additional friction force is applied tangentially at .015 m from the axis of rotation with magnitude 20 N at the same intant the 180 N force is applied, what is the <u>new</u> resulting α?





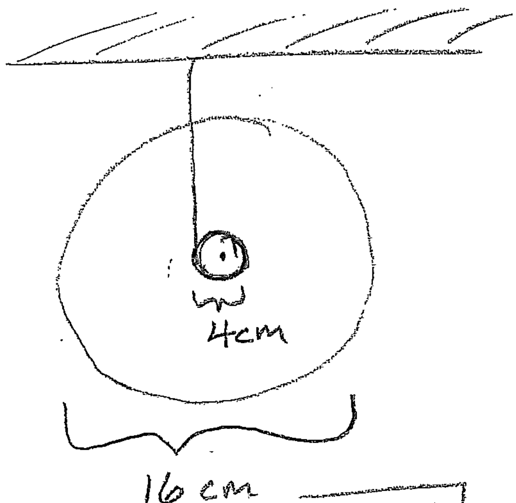
The mass blob has mass "M". The diameter of its base on which a string is wrapped is .1 meters. The string is connected to a hand pulling with tension 40N through a massless pulley system. If the angular acceleration of the blob is 3 rad/s/s, what is the blob's moment of inertia?



1. Determine the literal equation for the translational acceleration of the hanging mass 'm' in terms of M, m and g.

2. Assuming that $h = 4$ meters, $m = 7\,kg$, $M = 15\,kg$, $V_i = 0$ and $g = 20\,m/s/s$, what is the time required for 'm' to hit the ground?

A large yoyo of mass 80 grams and moment of inertia 5×10^{-5} kgm

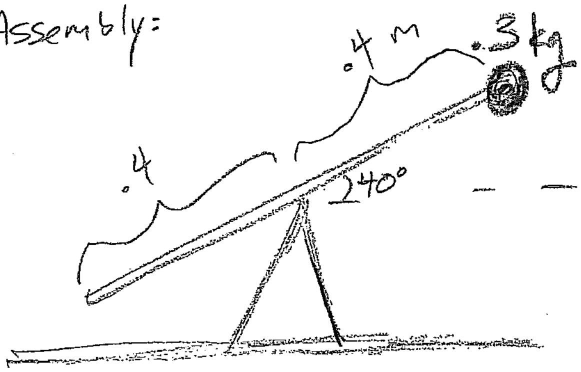


$\boxed{a = r\alpha}$

$g = 10$ m/s/s

1. Draw a free body diagram for the yoyo.
2. Write the literal net force equation for the vertical direction. Solve for tension.
3. Using the two torque equations: $\Sigma\tau = r_{\perp}F$ & $\Sigma\tau = I\alpha$ to create a literal equation for tension.
4. Combine the equations you created in #2 and #3 and solve for 'a'.
5. Solve for tension in the string.
6. Solve for α of the yoyo.

Assembly:



$I_{rod} = \frac{1}{12} m L^2$

$I_{point\ mass} = m r^2$ $g = 10\ m/s/s$

A uniform rod .8 m long with mass of .5 kg is pivoted at its midpoint. A .3 kg point mass is placed on the right side as shown and the rod is tilted 40° from the horizontal.

1. Find α of the assembly
2. Find a of the .3 kg mass.

* Hints:
1. Use the two net torque equations; set them equal to one another. $\Sigma \tau = I\alpha$ $\Sigma \tau = r \cdot F \cdot \sin\theta$
2. To find I_{total} sum $I_{rod} + I_{point\ mass}$.
3. The torque from the rod only is at the pivot point; the torque from the .3 kg force/gravity is at the rod's end.

An external torque is applied to an object with a narrow base. Which location for the center of mass would make the object less likely to tip over?

A just above the base

B high above the base

C just outside the base

D far outside the base