Rotational Dynamics

- What causes rotational motion to change?

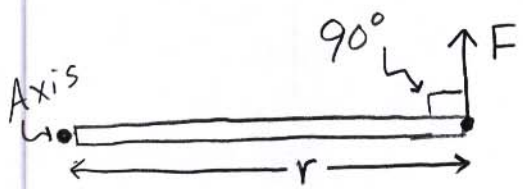
Torque (τ) ← tau stands for torque

- torque causes angular "twist"
- the ability of a force to rotate an object

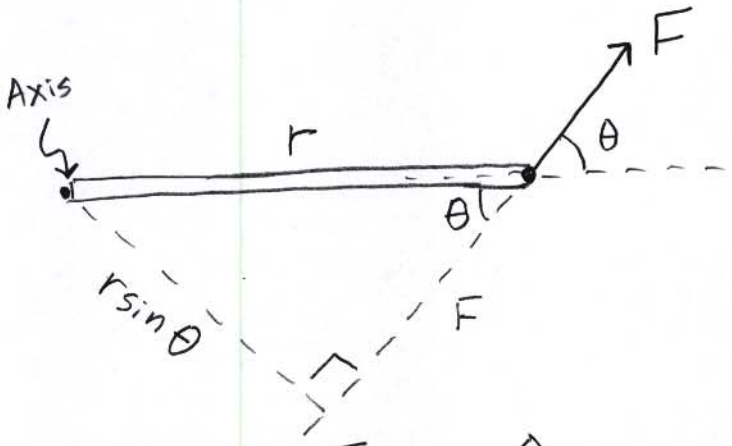
$$\Sigma\tau = F \cdot r \sin\theta$$

SI unit $(N \cdot m)$

- only the component of force perpendicular to (r) can cause torque.



$\tau = F \cdot r \sin(90°) = F \cdot r$

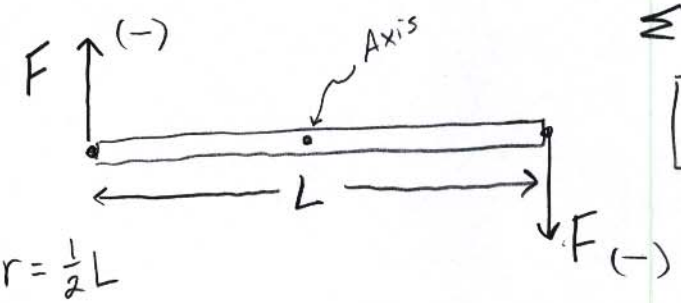


$\Sigma\tau = F \cdot r \sin\theta$

For multiple torques

$$\Sigma\tau = \tau_1 + \tau_2 + \tau_3 \ldots$$

★ Directions
counterclockwise (+)
clockwise (−)

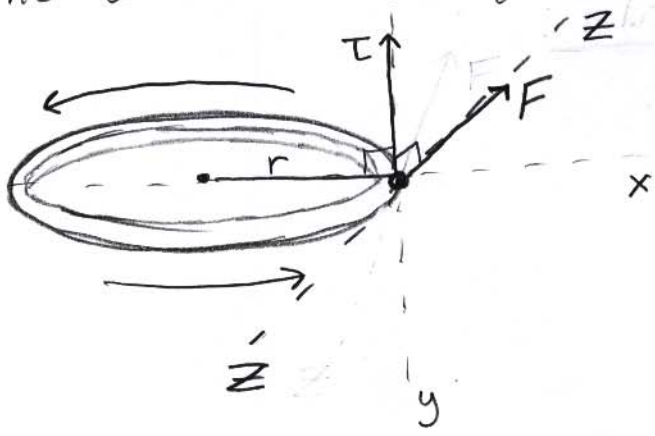


★ $r = \frac{1}{2}L$

$$\Sigma\tau = -F\tfrac{1}{2}L - F\tfrac{1}{2}L$$

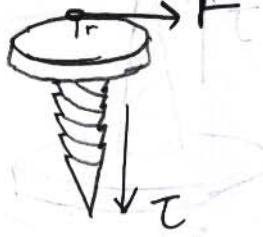
$$\Sigma\tau = -FL$$

The direction of torque and other angular quantities.



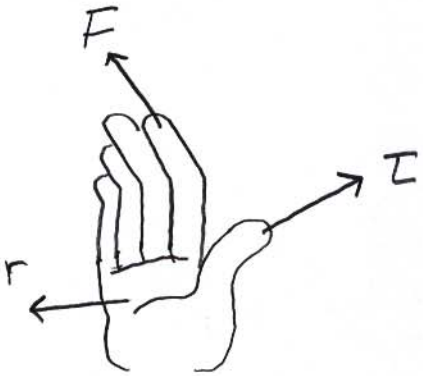
Torque is perpendicular to both (r) and (F)

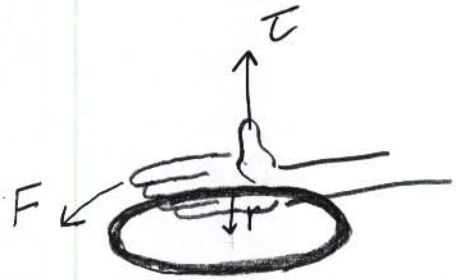
For the wheel to force is ⊥ to radius and torque is ⊥ to both (r) and (F)



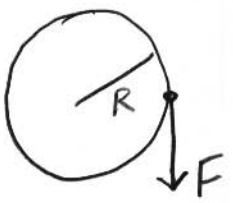
- Think of a screw
- When you apply the force in the correct direction the screw goes in.

We use the right-hand rule to determine direction of torque.





Ex:



$\Sigma\tau = F \cdot R$ into the page (X)

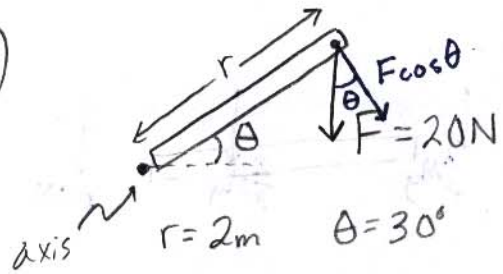
into page (X)

out of page (·)

Practice AP1

Rods Flat on table

1)



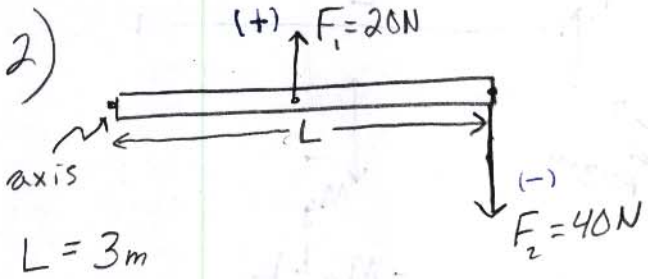
$r = 2m \quad \theta = 30°$

$\Sigma\tau = -F\cos\theta \cdot r$

clockwise

$\boxed{\Sigma\tau = -34.6\ N\cdot m}$

2)

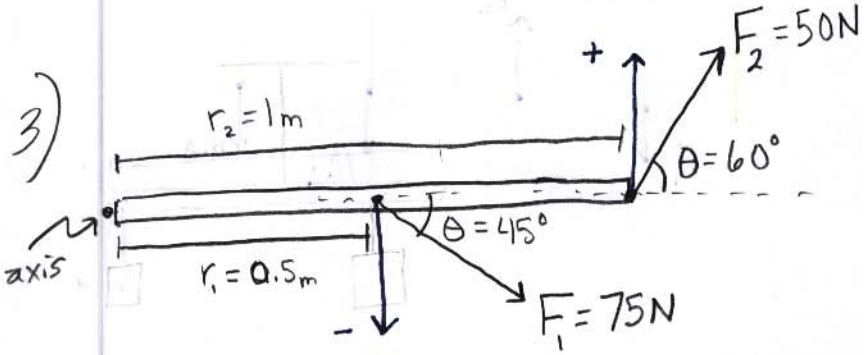


$L = 3m$

$\Sigma\tau = F_1 \frac{1}{2}L - F_2 L$

$\boxed{\Sigma\tau = -90\ N\cdot m}$

3)

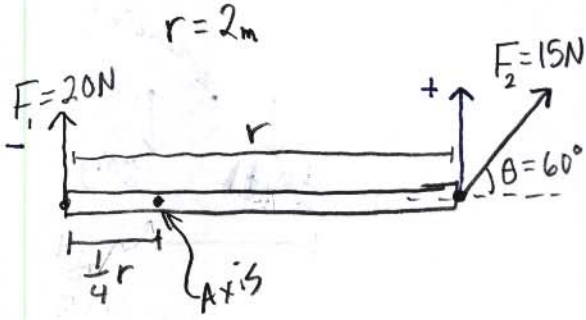


$\Sigma\tau = -F_1 \sin 45 r_1 + F_2 \sin 60\, r_2$

$\Sigma\tau = -26.5 + 43.3$

$\boxed{\Sigma\tau = 16.8\ N\cdot m}$

4)

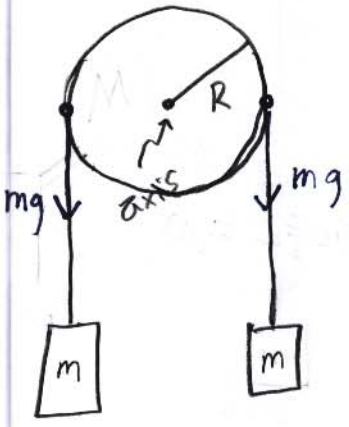


$\Sigma\tau = -F_1 \frac{1}{4}r + F_2 \sin\theta \frac{3}{4}r$

$\Sigma\tau = -10 + 19.5$

$\boxed{\Sigma\tau = 9.5\ N\cdot m}$

5)

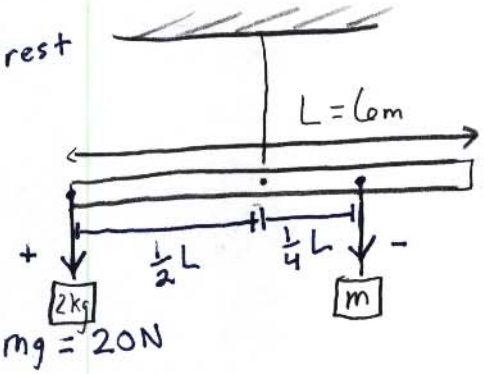


at rest

$\Sigma\tau = \emptyset$

$mgR - mgR = \emptyset$

6)



$mg = 20N$

What is m?

$\Sigma\tau = \emptyset$

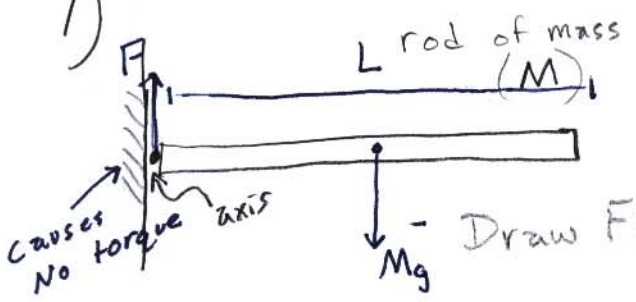
$20 \frac{1}{2}L - mg \frac{1}{4}L = \emptyset$

$10L = mg\frac{1}{4}L$

$\frac{10}{g} = m\frac{1}{4}$

$\boxed{m = 4kg}$

7)



Draw FBD

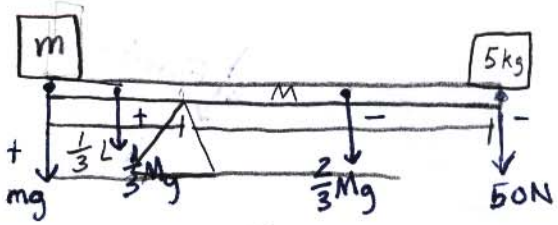
$\Sigma\tau = -Mg\frac{1}{2}L$

going to fall.

8)

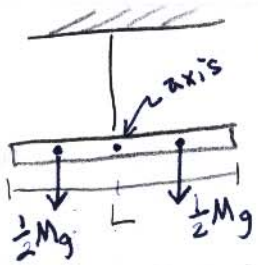
rod mass = 10kg

L = 10m



What is m?

9)

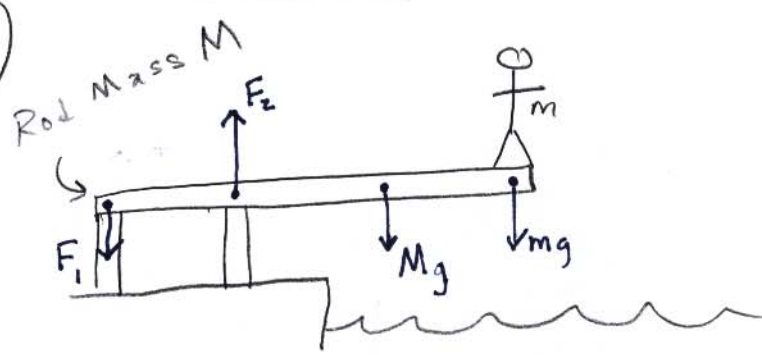


Draw FBD

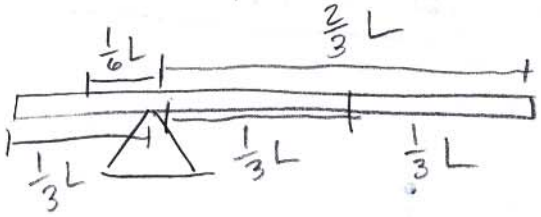
$\Sigma\tau = \emptyset$

$\frac{1}{2}Mg\frac{1}{2}L - \frac{1}{2}Mg\frac{1}{2}L = \emptyset$

10)



8 continued



$\Sigma\tau = \emptyset$

$mg\frac{1}{3}L + \frac{1}{3}Mg\frac{1}{6}L - \frac{2}{3}Mg\frac{1}{3}L - 50\frac{2}{3}L = \emptyset$

solve