Read 8.6-8.7

Exam Monday 7:30 a.m. Chp 6,7

Group problem tomorrow (2D collisions)

Action Center tomorrow

office hours 9:30-10:30 today

see very nice correspondence between linear variables and angular variables

linear		angular	
x	$\longleftrightarrow$	θ	(theta)
v	$\longleftrightarrow$	ω	(omega)
a	$\longleftrightarrow$	α	(alpha)

linear	angular
$x = x_0 + v_{av} t$	$\theta = \theta_0 + \omega_{av} t$
$v_x = v_{0x} + at$	$\omega = \omega_0 + \alpha t$
$x = x_0 + v_0 t + \frac{1}{2} a t^2$	$\theta = \theta_0 + \omega_0 t + \frac{1}{2} \alpha t^2$
$v^2 = v_0^2 + 2a\Delta x$	$\omega^2 = \omega_0^2 + 2\alpha \Delta\theta$
Need constant acceleration	Need constant angular acceleration

EX] A cyclist starts from rest and pedals so that the wheels make 8.0 revolutions in the first 5.0 s what is the angular acceleration of the wheels?

$t = 5s \qquad \omega_0 = 0 \qquad \theta_0 = 0$

$\theta_f = 8\,\cancel{rev} \cdot \frac{2\pi\, rad}{\cancel{rev}} = 16\pi$ radians

$$\theta = \cancel{\theta_0}^{0} + \cancel{\omega_0}^{0} t + \frac{1}{2}\alpha t^2$$

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

$$\alpha = \frac{2\theta}{t^2} = \frac{2 \cdot 16\pi}{(5s)^2} = \boxed{4\ rad/s^2}$$

A turn table reaches its rated frequency of 33.3 rpm in 2.0s starting from rest.

a) what is the angular acceleration?

b) How many revolutions does it make during this time?

$t = 2s \qquad f = 33.3 \text{ rev/min}$

$$\frac{33.3 \cancel{\text{rev}}}{\cancel{\text{min}}} \Big| \frac{2\pi \text{ rad}}{1 \cancel{\text{rev}}} \Big| \frac{\cancel{1 \text{ min}}}{60 s} \Big| = 3.48 \text{ rad/s}$$

(ω) angular velocity

$\omega_0 = 0$

$\alpha = ?$ $\qquad \omega = \cancel{\omega_0}^{0} + \alpha t$

$$\alpha = \frac{\omega}{t} = \frac{3.48 \text{ rad/s}}{2s} = \boxed{1.7 \text{ rad/s}^2}$$

$$\theta = \cancel{\theta_0}^{0} + \cancel{\omega_0}^{0} t + \frac{1}{2}\alpha t^2$$

$$\theta = \frac{1}{2}\alpha t^2 \Rightarrow \frac{1}{2}(1.7 \text{ rad/s}^2)(2s)^2 =$$

$$\theta = 3.48 \text{ rad}$$

$1 \text{ rev} = 2\pi \text{ rad} \qquad 1 \text{ rad} = \frac{1}{2\pi} \text{ rev} = .159 \text{ rev}$

$$\frac{3.48 \text{ rad}}{} \Big| \frac{.159 \text{ rev}}{1 \text{ rad}} \Big| = \boxed{.55 \text{ rev}}$$

What causes something to rotate?

Translational motion: Force causes acceleration

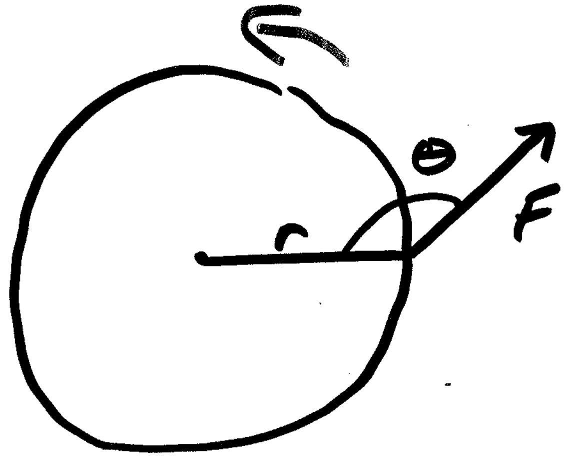
Rotational motion: also takes a force

One important difference

Location of where force applied very important

I must apply force away from axis of rotation

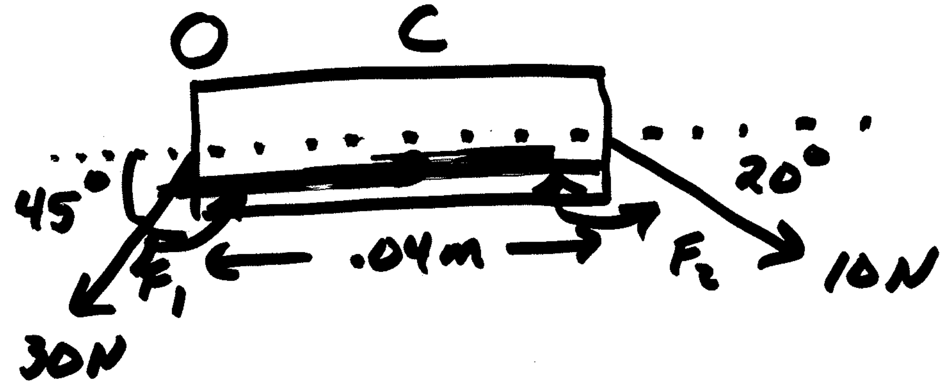
rotation depends on:
magnitude of Force (F)
how far from axis of rotation (r)
angle of force (θ)



Define torque (τ) "tau"

$\tau = rF\sin\theta$

θ = angle between direction of force and line drawn from axis of rotation to the force ex)



calculate torque around an axis $\perp$ to page a) point O b) point C

a) $\tau = rF\sin\theta$

$\tau_1 = \underbrace{r_1 F_1 \sin\theta_1}_{r_1 = 0 \quad \tau_1 = 0}$

$\tau_2 = r_2 F_2 \sin\theta_2$

$(.04m)(10N)\sin 160^\circ$

$\tau = \boxed{.14\ N\text{-}m}$

clockwise rotation defined as negative

$\boxed{-.14\ N\text{-}m}$

b) $\tau_1 = \overset{ccw}{+}(.02m)(30N)\sin 135^\circ$

$\tau_2 = \underset{cw}{-}(.02m)(10N)\sin 160^\circ$

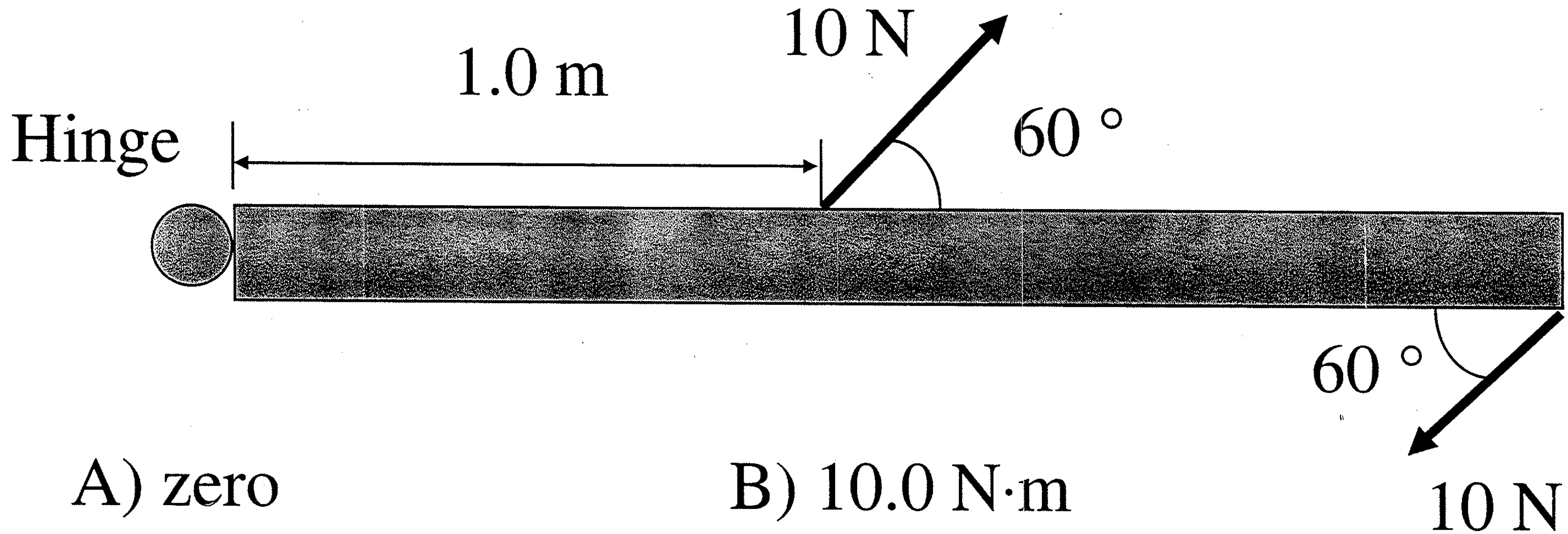
$\boxed{.36\ N\text{-}m}$

$\tau_{net} = \tau_1 + \tau_2$

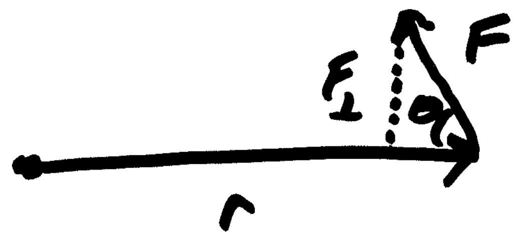
$\boxed{\text{rotating CCW}}$

Interactive Question

The diagram show the top view of a door that is 2 m wide. Two force are applied to the door as indicated in the diagram. What is the magnitude of the net torque on the door with respect to the hinge?



A) zero
B) 10.0 N·m
C) 4.0 N·m
D) 26.0 N·m
E) 8.7 N·m



$\tau = rF\sin\theta$

$\sin\theta = \frac{F_\perp}{F} \Rightarrow F_\perp = F\sin\theta$

$\tau = rF_\perp$

only component of force perpendicular to radius gives rise to torque

Linear motion $\Sigma \vec{F} = m\vec{a}$

Property of a body to resist change in velocity is mass

Property of a body to resist change in angular velocity is called

<u>moment of Inertia (I)</u>

moment of Inertia depends on mass, shape, axis of rotation

Let's calculate moment of Inertia for a sphere at the end of a string

$F_T = ma_T \quad a_T = r\alpha$

$F_T = mr\alpha$

$F_T r = mr^2\alpha$

$\tau = mr^2\alpha \qquad F = ma$

$I = mr^2 \qquad \tau = I\alpha$

$\Sigma \tau = I\alpha \qquad I = \Sigma mr^2$