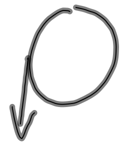
Torque



→ Tangential Forces to rotational motion.

$$F_T = m a_T$$

$\frac{d\omega}{dt}$ $\quad v_T = r\omega$

$a_c = r\omega^2 \qquad a_T = r\alpha$

$\omega = \frac{2\pi}{T}$ or $\frac{d\theta}{dt} \qquad \frac{d^2\theta}{dt^2}$

Torque $= \tau = F_T r = m a_T r = m r^2 \alpha$

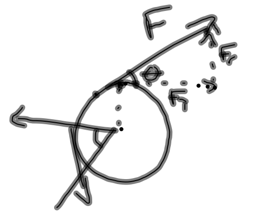
Treat rigid objects as sum of all the individual particles

$$\tau_{i\,net} = m_i r_i^2 \alpha$$

$$\sum \tau_{i\,net} = \left(\sum m_i r_i^2\right)\alpha = I\alpha$$

$$\boxed{\tau_{netext} = I\alpha}$$ Newton's second Law for torque.

think torquenetext = I "a"



$F_T = F\sin\phi$

Torque - Moment of Force

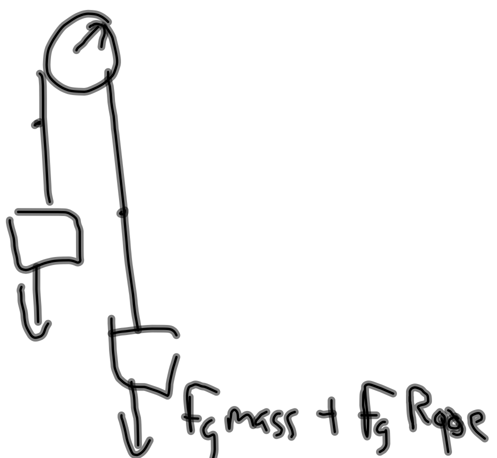
$$\tau = F_T r = F\sin\phi\, r = F\ell$$

length of moment arm (lever)

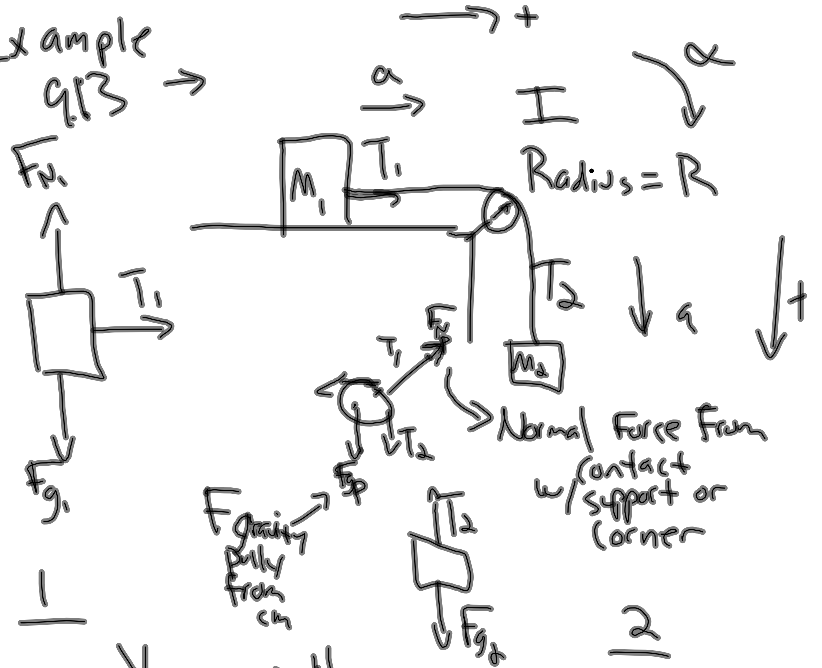
Non Slip - pulley systems

→ rope or string going around pulley has the same tangential velocit as pulley itself

$V_T = R\omega$: R = radius of pulley



Example 9.13 →



1

x	y	pulley rotational
T_1	$F_{g_1} - F_N$	$-T_1 R$ $T_2 R$
$m_1 a$	0	$I\alpha$

2

x	y
/	$F_{g_2} - T_2$
	$m_2 a$

$\boxed{a, T_1 + T_2}$

$T_1 = m_1 a$

$m_2 g - T_2 = m_2 a$

$T_2 R - T_1 R = I\alpha$

$T_2 = m_2(g-a)$

$T_1 = m_1 a$

$T_2 = m_2(g-a)$

NonSlip $\leftarrow$ $\alpha = \dfrac{a_T}{r}$

$a_T = a$

$r = R$

$a_T = r\alpha$

$$T_2 R - T_1 R = \frac{I a}{R}$$

$$m_2(g-a)R - m_1 a R = \frac{I a}{R}$$

$$m_2 g R - m_2 a R - m_1 a R = \frac{I a}{R}$$

$$m_2 g R = \left(\frac{I + m_2 R^2 + m_1 R^2}{R}\right) a$$

$$a = \frac{m_2 g R^2}{I + m_2 R^2 + m_1 R^2}$$