Some useful relations:

ω_0 = orig value of ω
θ_0 " " " θ

if α is constant ... $\omega = \omega_0 + \alpha t$

[NOTE SIMILARITY to EQN's FOR LINEAR ACCLN] $\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$

$\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$

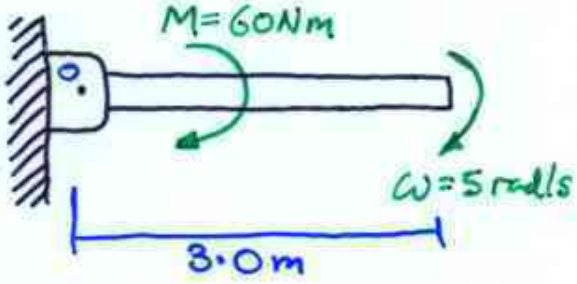
if α is not constant, more general expressions needed

$\alpha = \frac{d\omega}{dt} = \frac{d^2\theta}{dt^2}$; $\omega = \frac{d\theta}{dt}$; $\alpha\, d\theta = \omega\, d\omega$

AN EXAMPLE: Moment $M = 60\,Nm$

20.0 kg slender rod rotates in vertical plane. $\omega = 5\,rad\,s^{-1}$

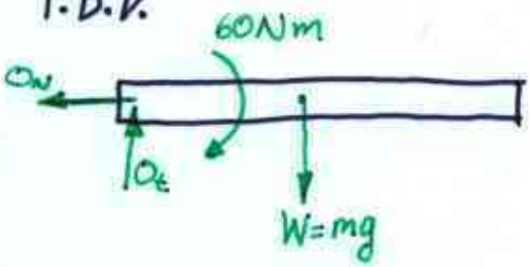
FIND α & components of forces @ O



3 UNKNOWNS O_N, O_t, α

EQUATIONS...

F.B.D.



$\overset{+}{\rightarrow}\sum F_N = ma_N$

$O_N = m r_G \omega^2 = (20)(1.5)(5)^2 = 750N$

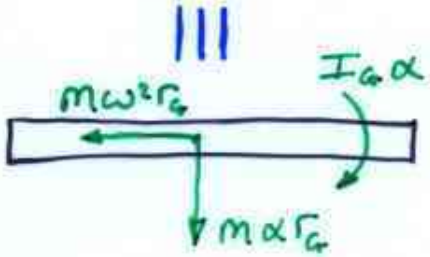
$+\uparrow \sum F_t = ma_t$

$-O_t + mg = m\alpha r_G$ ①

$\sum M_G = I_G\alpha \Rightarrow O_t r_G + M = I_G\alpha$

$-O_t(1.5) - 60 = -\left[\frac{1}{12}(20)(3)^2\right]\alpha$ ②

be careful with signs.



note: $I_G = \frac{1}{12}ml^2$ for rod

SOLVE BETWEEN ① & ②

$\Rightarrow O_t = 19.05\,N$

$\alpha = 5.905\,rad\,s^{-2}$