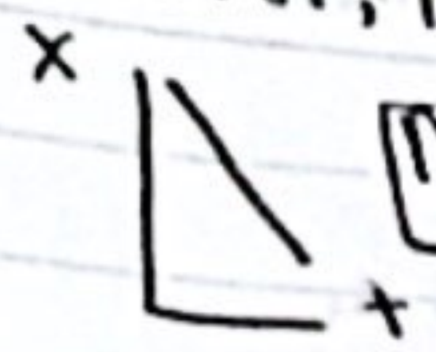
Benda tegar

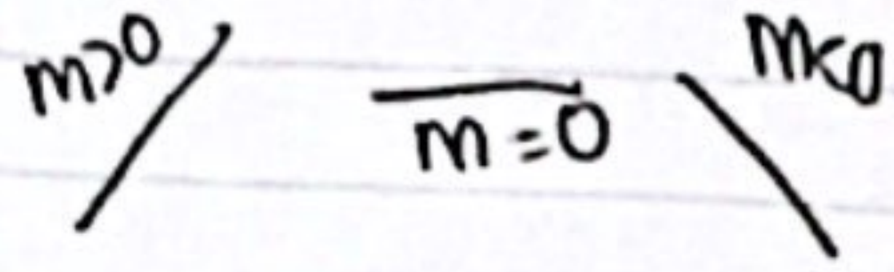
↳ Torsi, momen inersia



$m = v(t)$

$\omega = \theta$

ω: gradien

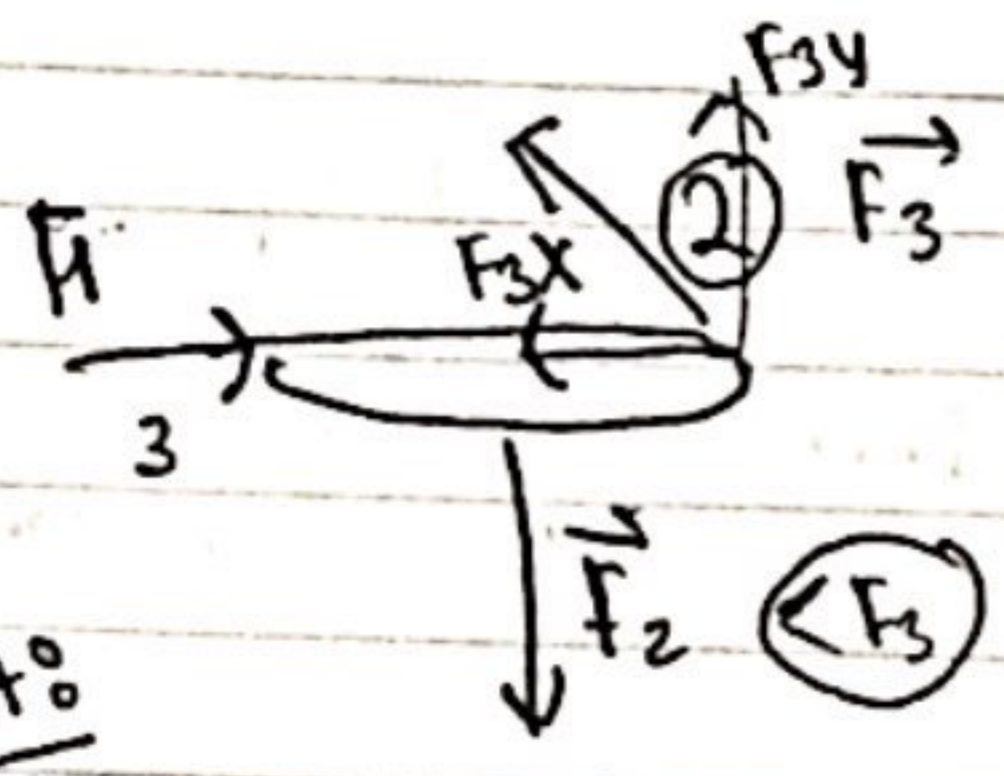


$\alpha = \frac{d\omega}{dt} < 0$

↳ karena
· ω berkurang

linear	sudut
$x, \Delta x$	$\theta, \Delta\theta$
$v = \frac{dx}{dt}$	$\omega = \frac{d\theta}{dt}$
$a = \frac{dv}{dt} = \frac{d^2r}{dt^2}$	$\alpha = \frac{d\omega}{dt} = \frac{d^2\theta}{dt^2}$

(2)



syarat:
setimbang → $\Sigma\vec{F} = 0$ → $\Sigma F_x = 0$, $\Sigma F_y = 0$, $\Sigma F_z = 0$
→ $\Sigma\vec{\tau} = 0$

$\vec{F_1}$ & F_{3x} dapat saling menghilangkan. $F_1 \rightarrow \; \leftarrow F_3$

$\vec{F_1} + \vec{F}_{3x} = 0$

$F_{3y} < F_2$ (tdk saling cancel)

•) pada sumbu y
$|\vec{F_2}| > |\vec{F}_{3y}|$

maka

$\Sigma F_y \neq 0$

∴ Benda tak mungkin setimbang

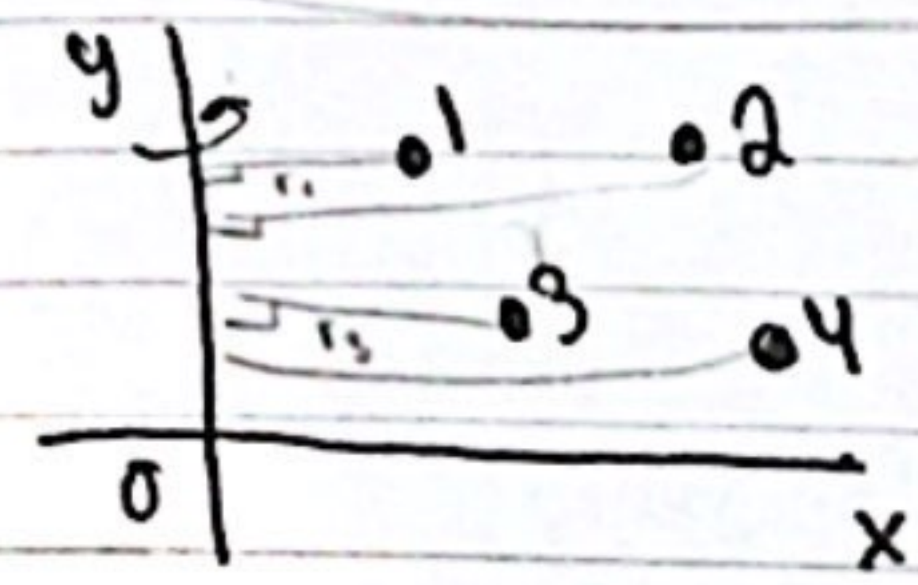
F_2 gaya yg paling panjang

(3) Momen inersia (sukar/mudahnya benda diputar)

(1) Sistem benda diskrit

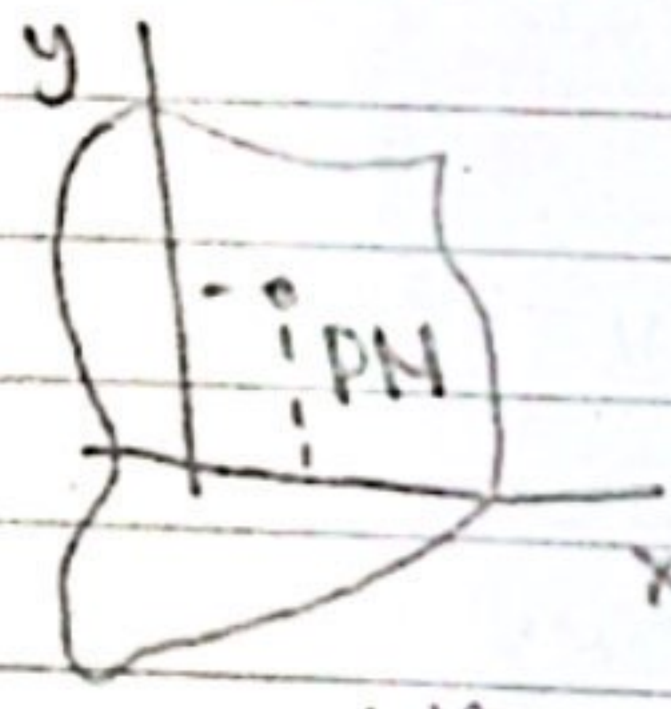
Momen inersia (semakin besar), sulit jg diputer.

⇐) momen = penyebab gerakan

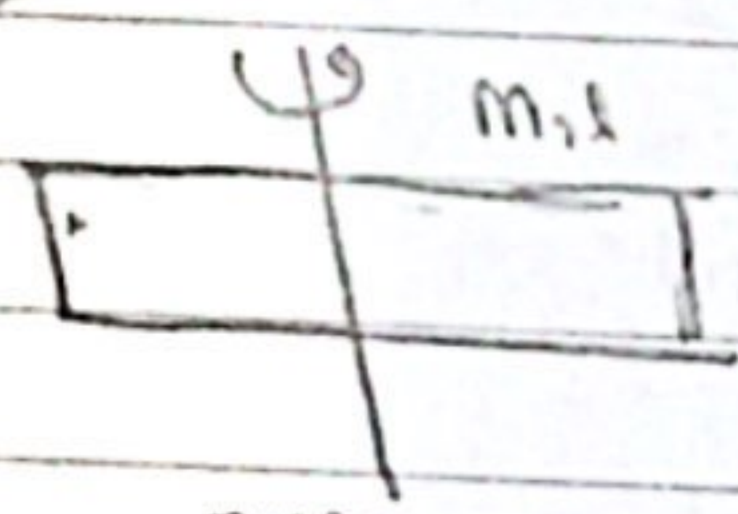


$I_y = \sum_{i=1}^{n} m_i r_i^2$
↓ jarak benda tegak lurus thdp sumbu rotasi

(2) Benda kontinu



$I_x = \int r^2 \, dm$
↳ I_{pm} = ada dibuku



pusat massa

$I_{pm} = \frac{1}{12} m l^2$

Teorema sumbu sejajar:

↳ kasus jika I dihitung terhadap sumbu bukan dipusat massa (digeser)

$I' = I_{pm} + Md^2$
↳ pergeseran paralel

a. $I_y = Ma^2 + Ma^2$

$= 2Ma^2$

b. $I_o = Ma^2 + Ma^2 + Mb^2 + Mb^2$

$= 2Ma^2 + 2Mb^2$

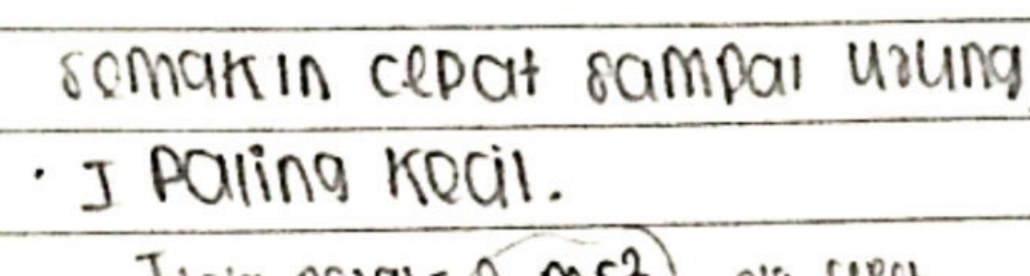
$I_o > I_b$

4) torsi.

penyebab benda berotasi

$\vec{\tau} = \vec{r} \times \vec{F} = r\,F \sin\theta\, \hat{n} = r\,F_\perp \hat{n}$

lengan = posisi titik gaya terhadap sumbu putar (titik engsel) / pivot



<Besar torsi>:

$\tau = r\,F_\perp$

$= L\,F \sin\phi$

Dinamika Rotasi =

hkm. newton = $\Sigma F = m.a$

$\rightarrow \Sigma\tau = I.\alpha$

(gerak lurus)

5) Dinamika rotasi =

semakin cepat sampai ujung lintasan:

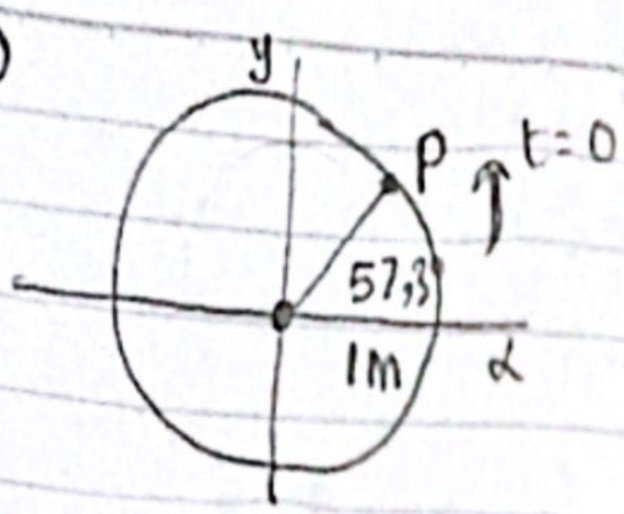
· I paling kecil.

$I_{bola\ pejal} = \frac{2}{5} mr^2$ plg cepat

$I_{silinder\ pejal} = \frac{1}{2} mr^2$

silinder berongga $= Mr^2$

Bola pejal, I silinder pejal, silinder berongga

① 

$\alpha = 4\ rad/s^2$

$t=0 \rightarrow \omega_0 = 0$

$\theta_0 = 57,3^\circ$

$= \frac{57,3}{180}\ \pi\ rad$

GLBB/GLB	GMBB/GMB
$X = X_0 + V_0 t + \frac{1}{2} a t^2$	$\theta = \theta_0 + \omega_0 t + \frac{1}{2} \alpha t^2$
$V = V_0 + at$	$\omega = \omega_0 + \alpha t$
$V^2 = V_0^2 + 2a\Delta x$	$\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$

a) $t: 2s \rightarrow \omega_2 = ?$

$\omega_2 = \omega_0^0 + \alpha t$

$= 4(2) = 8\ rad/s$

b) $v_{tangensial} = \omega R$

$= 8(1) = 8\ m/s$

percepatan:

gerak rotasi → $a_{tangensial} = \alpha . R$

→ $a_{sentripetal} = \frac{v^2}{R} = \omega^2 R$

$a_{tangensial} = 4(1) = 4\ m/s^2$

$a_{sentripetal} = 8^2(1) = 64\ m/s^2$

$a_{total} = \sqrt{a^2 + a^2}$

$= \sqrt{16+64} = 4\sqrt{5}\ m/s^2$

c) $\theta = \theta_0 + \omega_0 t + \frac{1}{2} \alpha t^2$

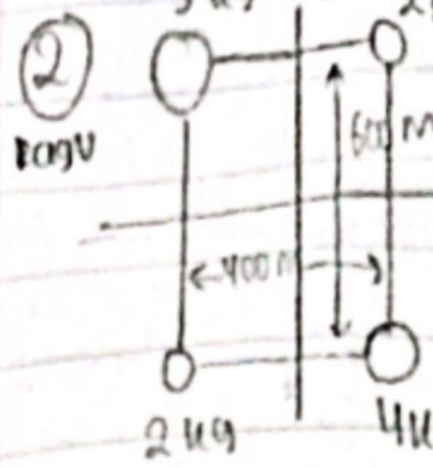
$= \frac{57,3}{180}\ \pi + \frac{1}{2} 4^2 (2)^2$

$= \frac{57,3}{180}\ \pi + 8$

$57,3^\circ + 8\ rad$

$\frac{8}{\pi} \times 180^\circ$

$2,54 \times 100^\circ \geq 360^\circ$ //

② 

hitung:

a. momen inersia

$\sqrt{2^2+3^2}$ ← thdp sumbu z

$\sqrt{13}$ m

b. energi kinetik rotasi sistem

a) $I = \Sigma m r^2$

$I = (3\ kg)(0,60\ m)^2 + (2\ kg)(0,60$

$+ (1\ kg)(0,60\ m)^2 + (4\ kg)$

$(0,60\ m)^2$

$I = 1,08\ kg.m^2 + 0,72\ kg.m^2 + 0,36$

$1,44\ m^2$

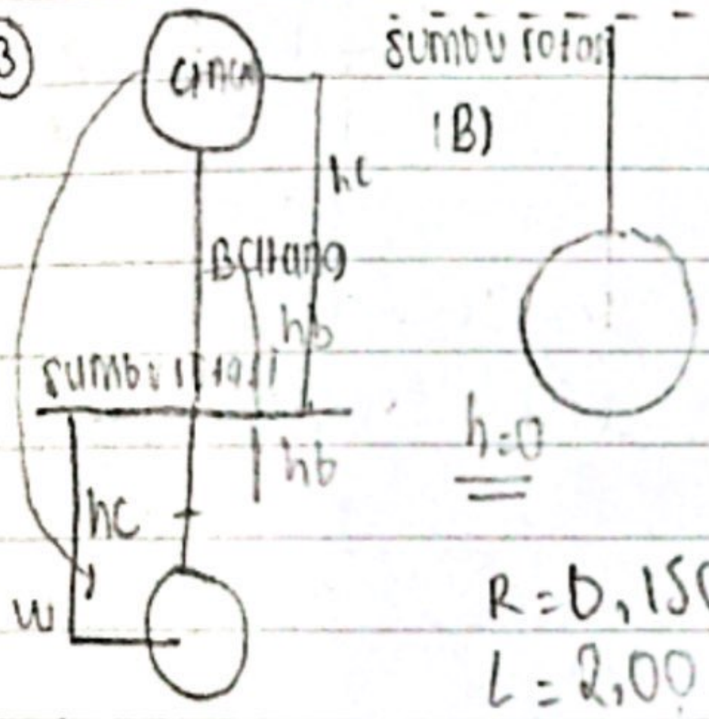
$= 3,6\ kg\ m^2$

b) $K = \frac{1}{2} I \omega^2$

$= \frac{1}{2}(3,6)\ kg\ m^2 . (6,00)^2\ rad/s$

$= 64,8\ J$ // $\frac{1}{2}.(43)(6)^2$

$= 2570\ J$ //

③ 

R = 0,150 m

L = 2,00 R

karena sistem urin maka sistem nonrevatif.

E.M total

$E_1 = E_2$

$mgh_c + mgh_b = mg(-h_b) + mg(-hc) + \frac{1}{2}(I_b + I_c)w^2$

$K_E = \frac{1}{2} I w^2$

$\frac{1}{2}L$

$1/3 mL^2$

$\frac{1}{2} MR^2 + m(R+L)^2$

$m(R+L)^2$

$R = 0,150$

$L = 2R$

$= 2(0,150) = 0,3\ m$

* $I = I_{com} + mR^2$

$E_1 = E_2$

$y_{rm} = \frac{m_1 y_1 + m_2 y_2}{m_1 + m_2}$

$W = ?$

$I = I_{cm} + mR^2$

$I_{hoop} = \frac{1}{2}mR^2 + m(R+L)^2$

$I_{rod} = \frac{1}{12}mL^2 + m(\frac{1}{2})^2$

$2mg(\Delta y_{pm}) = \frac{1}{2} I w^2 + 0$

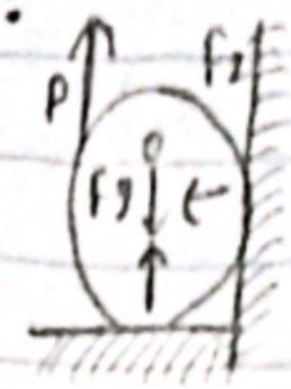
$2mg(\Delta y_{pm}) = \frac{1}{2} .10,833 mR^2 w^2$

$w^2 = \frac{4g(\Delta y_{pm})}{10,833R^2}$

$w = \sqrt{\frac{4(9,8)(4)(0,150)}{(10,833)(0,150)^2}}$

$= 9,82320\ rad/s$

5. Diket:



$F_s = 0,500\ N$

N_2 → gaya normal horizontal F_2

F_g = berat silinder

P = gaya max

Ket untuk kesetimbangan linier

$P = F_g - N_1 - F_2$ ① and $N_2 = F_1$ ②

$N_2 = F_1 = 0,5\ N$

$F_2 = 0,5 N_2$

$= 0,5(0,5 N_1)$

$= 0,25 N_1$

③ $P = 0,5 N_1 + 0,25 N_1$

$= 0,75 N_1$

① $P = F_g - N_1 - 0,25 N_1$

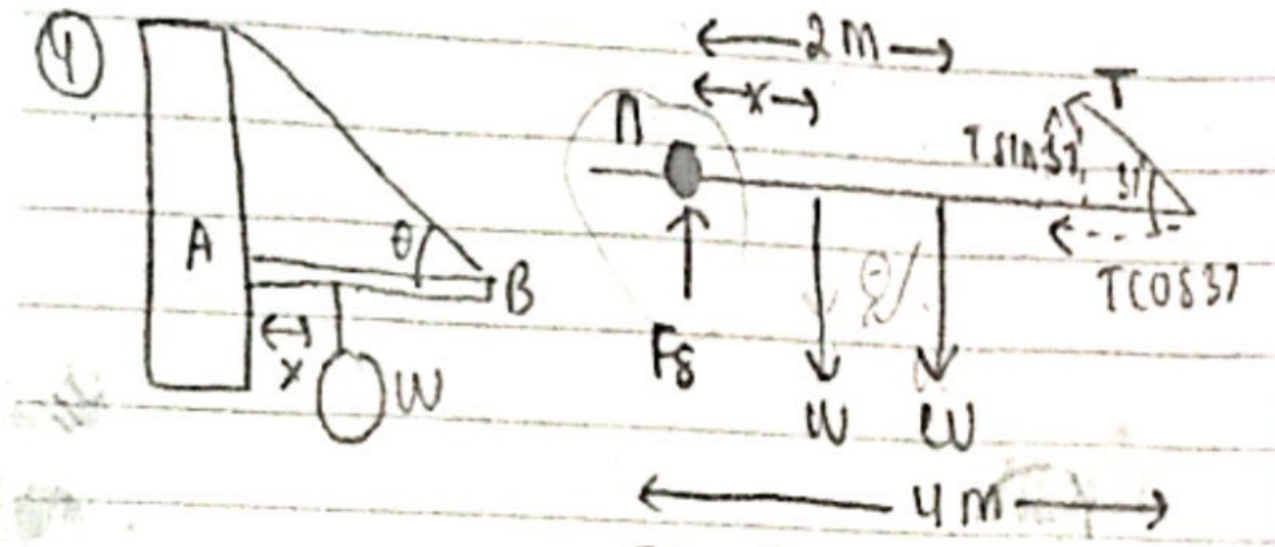
$= F_g - 1,25 N_1$

⑤ $N_1 = \frac{P}{0,75}$

$P = F_g - (1,25 \times \frac{4P}{3})$

$= F_g = \frac{3P+5P}{3} = \frac{8P}{3}$

$P = \frac{3F_g}{8}$ //



$\Sigma F_y = 0$

$F_s + T \sin 37 - 2W = 0$

$\Sigma F_x = 0$

$N - T\cos 37 = 0$

$N = T\cos 37$

$M_8 . T\cos 37 + T \sin 37 - 2W = 0$

$(0,5) T \cos 37 + T \sin 37 - 2W = 0$

$0,4T + 0,6T - 2W = 0$

$T = 2W$

$\Sigma \tau = 0$

$-Wx \sin 90 - W(2) \sin 90 + T(4) \sin 37 = 0$

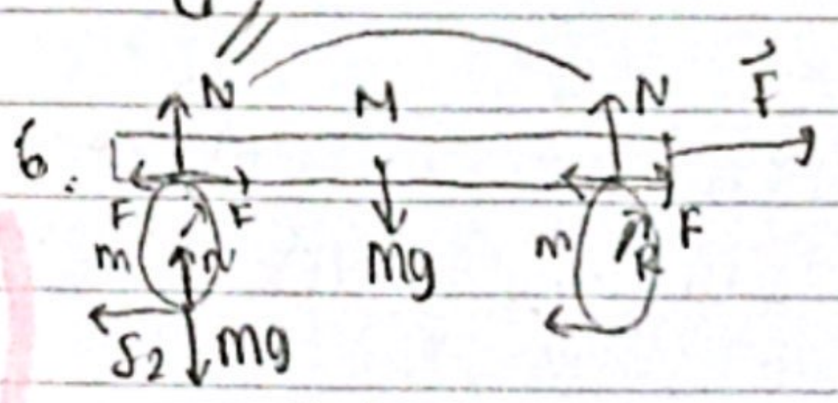
$-Wx - 2W + 4t \sin 37 = 0$

$-\frac{Wx}{W} - \frac{2W}{W} + 4(\frac{2W}{W}) \sin 37 = 0$

$-x - 2 + 8 \sin 37 = 0$

$x = 2,8\ m$

6.



* $\Sigma F = M . a$

$F - f = Ma$

* $\Sigma \tau = I . \alpha$

$F - F_k = (\frac{1}{2}R^2)(\frac{a}{R})$

* $\Sigma F = m . a$

$F - f_s - f_k = (2m+M)a$

$F - 2f_k = (2m+M)a$

$\Sigma F_x = 0$ c) $6{,}00\,N - 2T_1 = 6{,}00\,kg\,a$

$a = \frac{a_P/2}{5\,cm} = \frac{a_P}{(0{,}1\,m)}$

+a.) $600\,N - (11{,}50\,kg)a_P = 6{,}00\,kg\,a$

$a_P = 0{,}8\,m/s^2$

$a = \frac{a_P}{2} = 0{,}4\,m/s^2$

b.) $2T_1 = (1{,}5\,kg)a_P = 2T_1 = (1{,}5)(0{,}8)$

$= 0{,}6\,N$

$F_1 + F_b = (0{,}5\,Kg)a_P$

$= 0{,}600\,N + F_b = 0{,}200\,N$

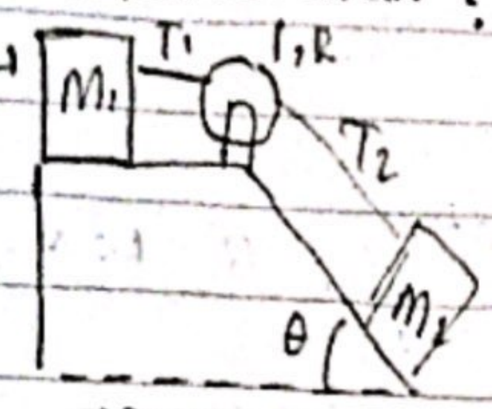
⑦ Diket $m_1 = 2\,kg$

$m_2 = 6{,}0\,kg$

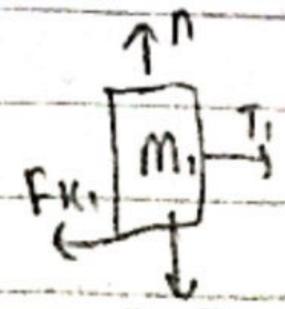
$R = 0{,}250\,m$

$M = 10{,}0\,kg$

Dit: a) percepatan ?



Tinjau m_1:



$\Sigma F_y = m.a_y$

$= n - mg = 0$

$n_1 = M_1 g = 19{,}6\,N$

$f_{k1} = \mu_k . n_1 = 7{,}06\,N$

$\Sigma F_x = ma_x$

$= -7{,}06\,N + T_1$

$= (2{,}00\,kg)a$

katrol:

$\Sigma \tau = I.\alpha$

$-T_1 + T_2 = (5)\,kg\,a$

m_2:

$n_2 = 6\,kg(9{,}0)(\cos 30°)$

$= 50{,}9\,N$

$-19{,}3\,N - T_2 + mg\sin\theta = ma$

a) $-7{,}06\,N - 19{,}3\,N + 29{,}4\,N = 13\,kg\,a$

$a = \frac{4{,}01\,N}{13{,}0\,kg} = 0{,}309\,m/s^2$

b) $T_1 = 2{,}00\,kg(0{,}309\,m/s^2) + 7{,}06\,N$

$= 7{,}67\,N$

$T_2 = 7{,}67\,N + 5\,kg(0{,}309\,m/s^2)$

$= 9{,}22\,N$

⑧ $W_F = \frac{1}{2}mv^2 + \frac{1}{2}Iw^2$

$mgH = \frac{1}{2}Mv^2 + \frac{1}{2}Iw^2 + Mgh$

$= \frac{1}{2}Mv^2 + \frac{1}{2}Mv^2 + Mgh$

$= \frac{1}{2}Mv^2 + \frac{1}{10}Mv^2 + Mgh$

$= \frac{7}{10}Mv^2 + Mgh$

$v = \sqrt{\frac{10}{7}g(H-h)}$

$= \sqrt{\frac{10}{7}(9{,}8)(6{,}0 - 2{,}0)}$

$= 7{,}48\,m/s$

$x = vt\,;\ y = \frac{-1}{2}gt^2$

$x = v\sqrt{\frac{2h}{g}}$

$= (7{,}48\,m/s)\sqrt{\frac{2(2{,}0\,m)}{9{,}8\,m/s^2}}$

$= 4{,}8\,m$

⑨ $v = \sqrt{2gh}$

$mvd = Iw$

$= (\text{bat atang} + md^2)w$

$= (\frac{1}{3}Md^2 + md^2)w$

$w = \frac{md\sqrt{2gh}}{\frac{1}{3}md^2 + md^2}$

hkm. kekekalan energi:

$$\frac{1}{2}Iw^2 = mgH + mg\frac{H}{2}$$

$$\frac{1}{2}\frac{m^2d^2(2gh)}{(Nd^2/3)+md^2} = \left(m+\frac{M}{2}\right)gd(1-\cos\theta)$$

maka diperoleh:

$$\theta = \cos^{-1}\left(1-\frac{m^2h}{d(m+N/2)(m+N/3)}\right)$$

$$= \cos^{-1}\left(1-\frac{h/d}{(1+\frac{N}{2m})(1+\frac{N}{3m})}\right)$$

$$= \cos^{-1}\left(1-\frac{20/40}{(1+1)(1+\frac{2}{3})}\right)$$

$$= 32^\circ$$

c) $U = mg(d/2)(1-\cos\theta)$

$$K_i = \frac{1}{2}Iw^2 = \frac{1}{2}(2M+m)\left(\frac{d}{2}\right)^2w^2$$

$$mg\frac{d}{2} + \frac{1}{2}(2M+m)\left(\frac{d}{2}\right)^2w^2 = mg\frac{d}{2}(1-\cos\theta)$$

$$\therefore \cos\theta = -\frac{1}{2}\left(\frac{2M+m}{mg}\right)\left(\frac{d}{2}\right)w^2$$

$$= -\frac{1}{2}\left(\frac{2(2)+0,05}{(0,05)(9,8)}\right)\left(\frac{0,5}{2}\right)$$

$$(0,1401) = -0,0276$$

$$\theta = 91,8^\circ + 90^\circ$$

$$= 181^\circ$$

10) a) $\frac{mvd}{2} = Iw$

$$I = (2M+m)\left(\frac{d}{2}\right)^2$$

$M = 2\,kg$

$$\frac{mvd}{2} = (2M+m)\left(\frac{d}{2}\right)^2 w$$

$$w = \frac{2mv}{(2M+m)d}$$

$$= \frac{2(0,05)(3)}{(2(2)+0,05)(0,5)} = 0,148\ rad/s$$

b) $\frac{K_F}{K_i} = \frac{Iw^2}{mv^2} = \frac{m}{2M+m} = \frac{0,05}{2(2)+0,05}$

$$= 0,0123$$