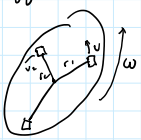
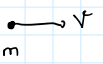
Energi Rotasi

Thursday, 07 October 2021 13.03

Energy kinetic Rotasi



$E_k = \frac{1}{2} m v^2$



$v_i = \omega r_i$ → kecepatan tangensial

$v_1 = v \cdot r_1$

$v_2 = \omega r_2$

$v_3 = \omega r_3$

$v_i = \omega r_i$

$K = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 + \dots + m_i v_i^2$

$= \frac{m_1 r_1^2 \omega^2}{2} + \frac{m_2 r_2^2 \omega^2}{2} + \dots + m_i r_i^2 \omega^2$

$K = \left(\sum_{i=1} m_i r_i^2 \right) \frac{\omega^2}{2} = \frac{I \omega^2}{2}$

$E_{K, \text{translasi}} = \frac{1}{2} m v^2$

$E_{k \text{ rotasi}} = \frac{1}{2} I \omega^2$

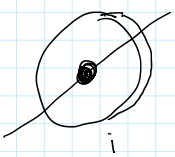
kelembaman $I \approx m$

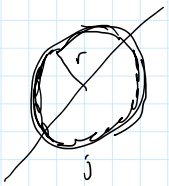
massa $\approx$ massa

semakin tinggi I ⇝ semakin malas benda dan semakin sulit digerakkan

$I = \sum m_i r_i^2$

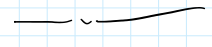
massa — distribusi massa





$I_i < I_j$

cakram → $I = \frac{1}{2} m r^2$  → kapasitansi cakram mudah ⇝ k lebih kecil

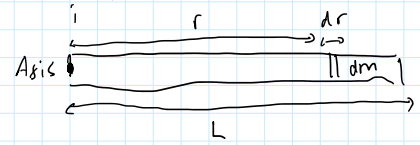
cincin → $I = mr^2$  →  cincin dipanjangkan → lebih besar

bola pejal → $I = \frac{2}{5} MR^2$

bola ronga → $I = \frac{2}{3} MR^2$

Momen Inersia Continue

$I = \sum_{i} m_i r_i^2$



$I = \int r^2 \, dm$

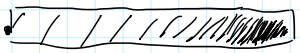
$\frac{dm}{dr} = \frac{M}{L}$

$dm = \frac{M}{L} dr$

$= \int r^2 \frac{M}{L} dr$

$= \frac{M}{L} \int_0^L r^2 dr = \frac{M}{L} \left[\frac{1}{3} x^3 \right]_0^L = \frac{M}{L} \frac{1}{3} L^3$

$= \frac{1}{3} M L^2$



$\frac{dm}{dr} = \lambda = \alpha_0 r$

$dm = \alpha_0 r \, dr$

$I = \int_0^L r^2 dm = \int_0^L r^2 \alpha_0 r \, dr$

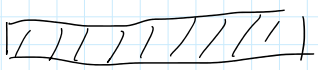
$= \alpha \int_0^L r^3 dr = \alpha_0 \frac{1}{4} L^4 = \frac{\alpha_0 L^4}{4}$

$M = \int_0^L dm = \int_0^L \alpha_0 r \, dr = \alpha_0 \int_0^L r \, dr = \alpha_0 \left. \frac{r^2}{2} \right]_0^L$

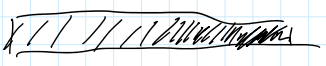
$M = \frac{1}{2} \alpha_0 L^2$

$I = \frac{1}{4} \alpha_0 L^4 = \frac{1}{2} \left[\overbrace{\frac{1}{2} \alpha_0 L^2}^{M} \right] L^2$

$= \frac{1}{2} M L^2$



$\frac{1}{3} M L^2$

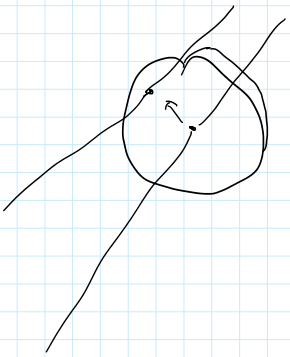


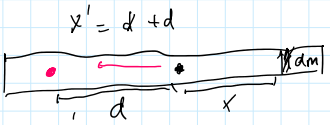
$\frac{1}{2} M L^2$

$\frac{1}{3} M L^2$ $\frac{1}{12} M L^2$

$I_1 < I_2$ besar yang ini

Parallel Axis Theorem





$$I = \int (x')^2 dm = \int (x^2 + 2xd + d^2)\, dm$$

$$= \int (x^2 + 2d(x' - d) + d^2) \cdot dm$$

$$= \int x^2 dm + 2d\left(\int x' \cdot dm - \int d \cdot dm\right) + d^2 \left(\int dm\right)$$

$$=$$

$$x'_{cm} = \frac{\int x' dm}{\int dm}$$

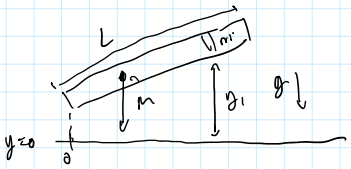
$$x'_{cm} = \frac{\int x' dm}{M}$$

$$M x'_{cm} = \int x' dm$$

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

Energi Potensial Gravitasi

$$E_p = mgh$$

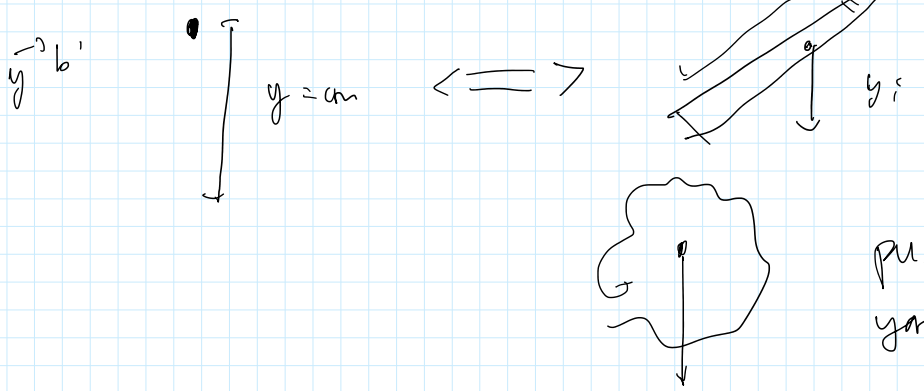


$$V_i = m_i g y_i$$

$$V = \sum_i V_i = g \sum m_i y_i$$

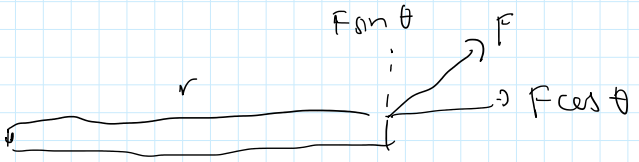
$$y_{cm} = \frac{\sum m_i y_i}{\sum m_i} = \frac{\sum m_i y_i}{M} = \sum m_i y_i = M y_{cm}$$

$U = g M y_{cm}$

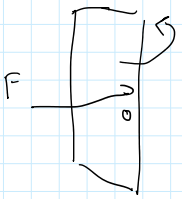


pusat massa yang pengaruh

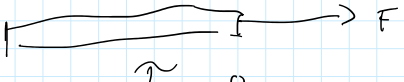
Torsi dan Statik Equilibrium



a Force F acts on a Rigid Body



Torque is a quantity that measure the "effectiveness" of a force act causing an Object to rotate about the pivot.



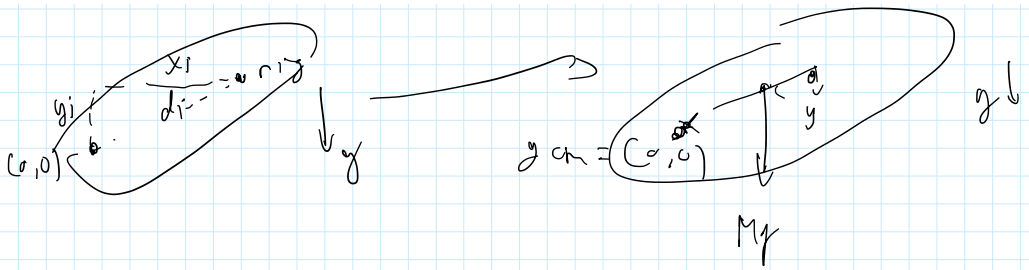
$\tau = 0$

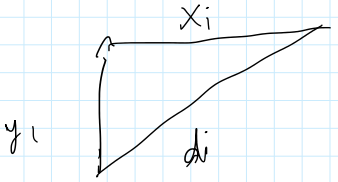
Cross Product:

$$\vec{\tau} = \vec{r} \times \vec{F} = |\vec{r}||\vec{F}| \cdot \sin\theta$$

$$\vec{r} \perp \vec{F} \longrightarrow \vec{v} \times \vec{w} \neq 0$$

$$\vec{r} \parallel \vec{F} \longrightarrow \vec{v} \times \vec{w} = 0$$





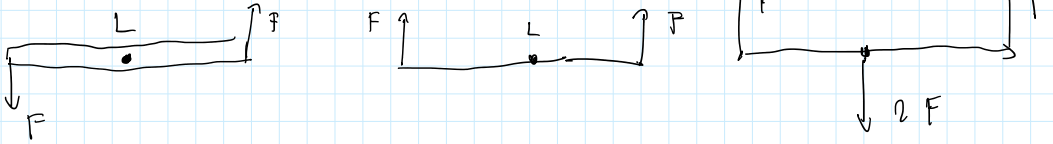
$m_i \cdot g \cdot x_i = \tau_i$

arah (−) searah jarum jam

$$\sum \tau_{i(grav)} = -\sum m_i g x_i = -g \sum m_i x_i$$

$$\tau_{(grav)} = -g M_i x_{cm}$$

Static Equilibrium



Pantun I

$$\sum F = 0 \rightarrow \sum F_x = 0 \quad \sum F_y$$

$$\sum \tau = 0 \rightarrow \sum \tau_x = 0 \quad \sum \tau_y = 0$$

Static equilibrium when

$$\sum \vec{F} = 0 \text{ and } \sum \vec{\tau} = 0$$

System I → $\sum F = 0$

but

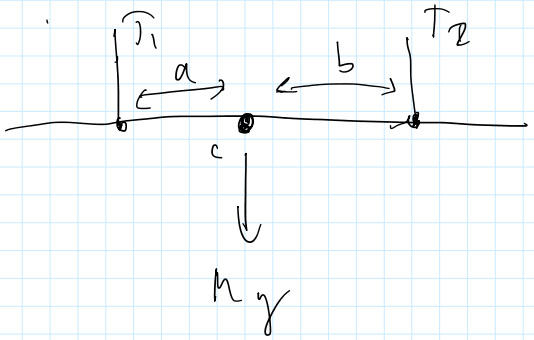
$\sum \tau \neq 0 = \sum \tau$

System II → $\sum F \neq 0 = \sum F$

$\sum \tau = 0$

System III → $\sum F = 0$

$\sum \tau = 0$



hitung T_1 & T_2?

$\sum F = 0$

$\sum F = T_1 + T_2 - mg = 0$

$T_1 = mg - T_2$

$\sum \tau = 0$

$\sum \tau = -T_1 a + T_2 \cdot b + 0 = 0$

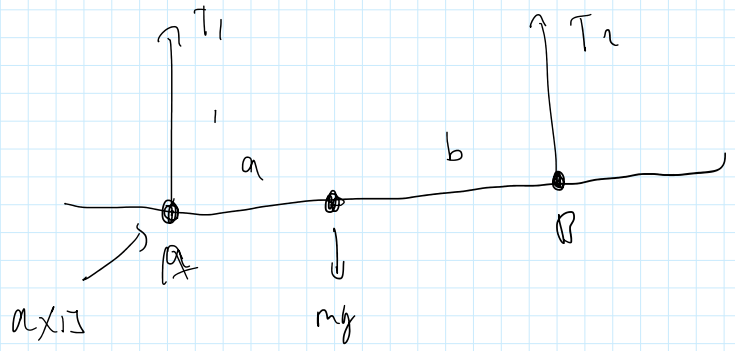
searah jarum jam

$T_2 b = T_1 a$

$T_1 + T_2 - mg = 0$

$-T_1 a + T_2 b = 0$

$T_1 - T_1 a + T_2 + T_2 b - mg$



$$\Sigma F = 0 : T_1 + T_2 - Mg$$

$$\Sigma \tau : Mg\,a - T_2(a+b) = 0 \qquad T_2 = Mg\left(\frac{a}{a+b}\right)$$