11/NOV/2024

gerak rotasi

dan Menggelinding

Translasi → Rotasi

- Posisi (x,y,z) (m) → Sudut (θ) $\theta = \frac{y}{r}$ (rad)
- Kecepatan (v) (m/s) → Kecepatan sudut (ω) $\omega = v/R$ (rad/s)
- Percepatan (a) (m/s) → Percepatan sudut (α) $\alpha = \frac{a}{R}$ (rad/s^2)
- Gaya (F) → Momen gaya (τ) <torsi> $\vec{\tau} : \vec{R} \times \vec{F}$ (Nm)
- Massa (m) (kg) → Momen inersia (I) $I = \Sigma m R^2$
- Hukum newton 2 ($\Sigma F = \vec{m}\, a$) → Hukum newton 2 ($\Sigma \tau = I \cdot \alpha$)
- Energi kinetik ($K_T = \frac{1}{2} m v^2$) (J) → Energi kinetik ($K_T = \frac{1}{2} I \omega^2$) (J)
- Momentum ($\vec{p}$) $\vec{p} = m \cdot \vec{v}$ → momentum sudut (L) $L = I \cdot \omega$

Latihan

① Suatu Disk diukur dengan sudut putar berubah $\theta(t) = -Ct^3 + bt + d$

a, b, C = Suatu konstanta

t (sekon) & θ (radian)

Diket: saat $t = 0$

$\theta = \frac{\pi}{4}$ rad

$\omega = 2$ rad/s

$t = 1,5$ s

$\alpha = 1,25$ rad/s²

Dit: a) Tentukan a, b, C

b) Berapa percepatan sudut $\theta = \frac{\pi}{4}$ rad

c) θ & ω berapakah saat disk: porc. sudut 3,5 rad/s²?

Jawab: $\theta(t=0) = \frac{\pi}{4} = -Ct^3 + bt + d$

$\frac{\pi}{4} = -C(0)^3 + b(0) + d$

$\frac{\pi}{4}$

$\alpha = \frac{\pi}{4}$ rad

* $\omega(t=0) = 2$ rad/s

cari fungsi $\theta(t)$:

$\omega(t) = \frac{d\theta}{dt} = \frac{d}{dt}(-Ct^3 + bt + \alpha)$

Ingat: $\frac{d}{dt}$ Posisi (θ) $\int dt$

↓ Kecepatan (ω)

↓ percepatan (α) ↑

$\omega(t) = \frac{d\theta}{dt} = \frac{d}{dt}(-Ct^3 + bt + \alpha)$

$\omega(t) = -3Ct^2 + b + 0$

$\omega(t=0) = 2$ rad/s $= -3Ct^2 + b + 0$

$2 = 0 + b$

$b = 2$ rad/s

* $\alpha(t=1,5) = 1,25$ rad/s²

cari fungsi $\alpha(t)$:

$\alpha(t) = \frac{d\omega}{dt} = \frac{d}{dt}(-3Ct^2 + b + 0)$

$= -6Ct + 0$

$\alpha(t=1,5) = 1,25$ rad/s² $= -6Ct$

$1,25 = -9C$

$C = \frac{1,25}{-9} = -0,138$ rad/s²

* $\theta(t) = -(-0,138)t^3 + (2)t + 1\frac{\pi}{4}$

$\theta(t) = 0,138t^3 + 2t + \frac{\pi}{4}$

$\omega(t) = -3(0,138t)^2 + 2$

$\omega(t) = 0,414t^2 + 2$

$\alpha(t) = 6(0,138)t$

$\alpha(t) = 0,828t$

b) Percepatan sudut $\theta = \frac{\pi}{4}$ rad ?

(a) α = ?

Cari t & subs t ($\alpha = \theta$ → g berhubungan)

$\theta = \frac{\pi}{4}$

$t = 0$

maka:

$\theta(t=0) = 0{,}020\,(0)$

$\boxed{\alpha = 0}$

c) θ = ? Ketika $\alpha = 3{,}5$

ω = ?

cari t

subs t

$\pi = 3{,}14$ rad

$\alpha = 0{,}020\,t$

$3{,}5 = 0{,}020\,t$

$t = \frac{3{,}5}{0{,}020} = 4{,}227$ s

$\theta(t = 4{,}227) = 0{,}130(4{,}227)^3 + 2(4{,}227) + \frac{3{,}14}{4}$

$\boxed{\theta = 19{,}66159}$

$\omega(t = 4{,}227) = 0{,}414(4{,}1227)^2 + 2$

$\boxed{\omega = 9{,}03662}$

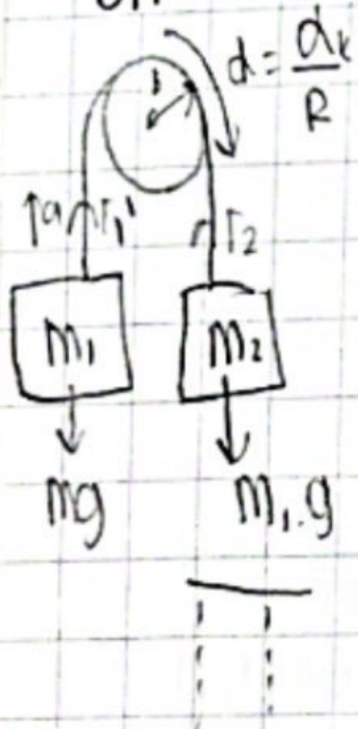
③ Balok bermassa $m_1 = 460$ g

$m_2 = 500$ g

$R = 5$ cm

m_2 turun = 75 cm dalam 5 s & katrol diputar

Dit = a) Besar percepatan!



$\delta = 75$ cm $= 0{,}75$ m

$t = 5$ s

#ingat

$V_t = V_0 + at$

$\delta = V_0 t + \frac{1}{2} a t^2$

$V_t^2 = V_0^2 + 2a\delta$

$0{,}75 = 0 \cdot t + \frac{1}{2} a (5)^2$

$0{,}75 = \frac{25}{2} a$

$a = \frac{0{,}75 \times 2}{25} = 0{,}06\ m/s^2$

$V_0 = 0$

b) gaya tegangan tali T_1!

(a) α ↑ m_1 ↓ $m_1 g$ (w)

$\Sigma F = m_1 a$

$T_1 - m_1 g = m_1 a$

$T_1 - (0{,}46 \times 10) = (0{,}46 \times 0{,}06)$

$T_1 - 4{,}6 = 0{,}0276$

$T_1 = 0{,}0276 + 4{,}6$

$= 4{,}0276$ N

c) gaya tegangan tali T_2!

(a) T_2 ↑ a_2 ↓ mg

$\Sigma F = m a$

$-T_2 + m_2 g = m_2 a$

$-T_2 + (0{,}5 \times 10) = 0{,}5 \cdot 0{,}6$

$-T_2 + 5 = 0{,}03$

$-T_2 = 0{,}03 - 5$

$-T_2 = -4{,}97$

$T_2 = 4{,}97$ N

d) Besarnya percepatan sudut putar!

$\alpha = \frac{a_t}{R} = \frac{a}{R} = \frac{0{,}06}{0{,}05} = 1{,}2$ rad/s²

e) momen inersia?

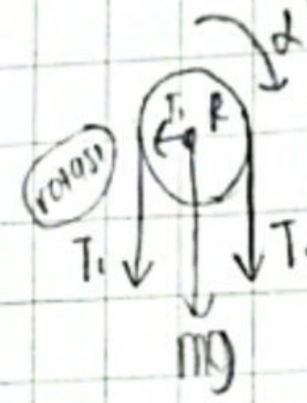
$I = \Sigma m r^2$ → satuan: kg m²

Katrol → berputar (rotasi)

↓

hkm. Newton 2 (rotasi)

$\Sigma \tau = I \cdot \alpha$



$\Sigma \tau = I \cdot \alpha$

$\Sigma(R \cdot F) = I \cdot \alpha$

$-(R \cdot T_1) + (R \cdot T_2) = I \cdot \alpha$

$-(0{,}05 \cdot 4{,}6276) + (0{,}05 \times 4{,}97) = I \cdot 1{,}8$

$-0{,}2314 + 0{,}2405 = I \cdot 1{,}2$

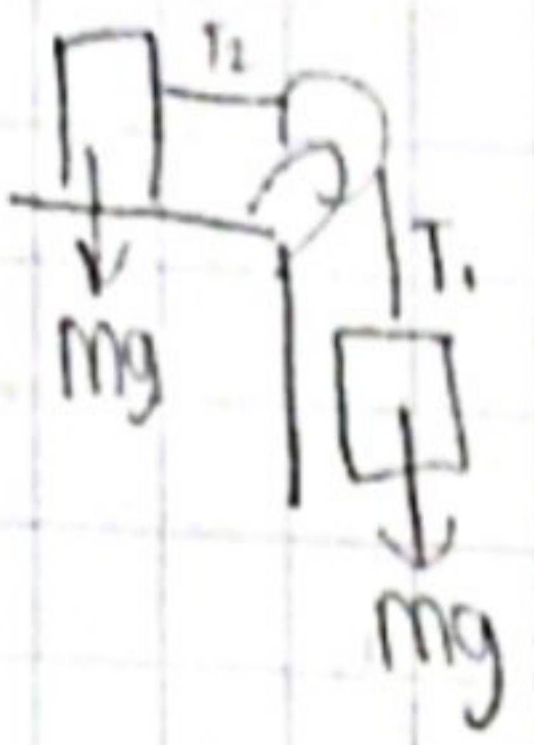
$0{,}0175 = I \cdot 1{,}2$

$I = \frac{0{,}0175}{1{,}2} = 0{,}0145$ Nm

(3) Pada gambar disamping dua buah balok masing² bermassa = 6 kg $m_1 = m_2$
tali ringan & katrol $r = 2$ cm $= 0{,}02$ m
Irotasi $= 7{,}4 \times 10^{-4}$ kg m² (I nagna)
Tali tidak slip dengan katrol & tidak ketahui apakah ada gesekan antar meja & balok yg meluncur.
sistem → dilepas
kondisi { diam
katrol → menempuh sudut $\theta = 0{,}1$ rad
waktu = 100 ms = 0,1 s
a = konstan

a) Uraikan persamaan dinamika gerak benda tsb!

=D



$m_1 = T_1 = m_1 \cdot a$
$m_2 g - T_2 = m_2 \cdot a$
k/rotasi =
$\boxed{\tau = I \cdot \alpha}$
$\tau = r(T_2 - T_1)$
$r(T_2 - T_1) = I \cdot \alpha$
$a = \alpha \cdot r$
$\alpha = \dfrac{a}{r}$
$r(T_2 T_1) = I\dfrac{a}{r}$

$T_2 = T_1 + \dfrac{I \cdot \alpha}{r^2}$

$T_1 + \dfrac{I \cdot \alpha}{r^2} = m_2 \cdot g - m_2 \cdot \alpha$

$m_1 \cdot \alpha + \dfrac{I a}{r^2} = m_2 g - m_2 a$

$a\left(m_1 + m_2 + \dfrac{I}{r^2}\right) = m_2 \cdot g$

$\alpha = \dfrac{m_2 g}{m_1 + m_2 + \frac{I}{r^2}}$

Hitung $= \dfrac{I}{r^2} = \dfrac{7{,}4 \times 10^{-4}}{(0{,}02)^2} = \dfrac{7{,}4 \times 10^{-4}}{4 \times 10^{-4}}$
$= 1{,}85$ kg

$\alpha = \dfrac{6 \times 9{,}8}{6 + 6 + 1{,}85} = \dfrac{58{,}8}{13{,}85}$
$= 4{,}25$ m/s² //

b) percepatan sudut katrol (α) & percepatan linier balok!

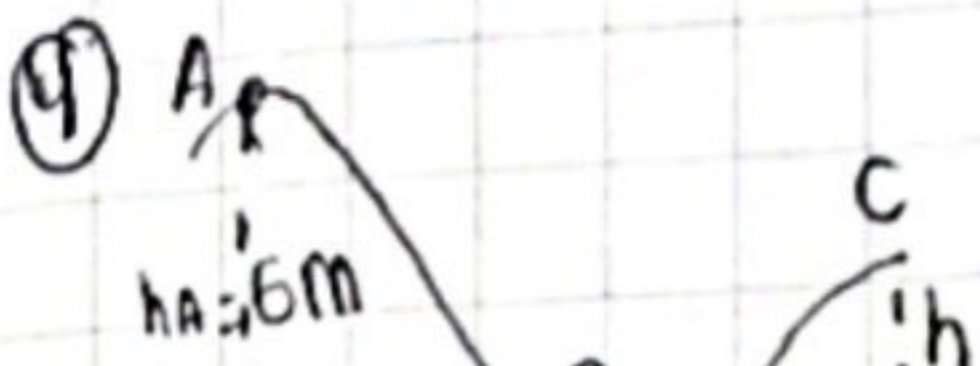
Dik $= \theta = 0{,}1$ rad
$t = 0{,}1$ s
$\boxed{\theta = \frac{1}{2} \alpha t^2}$
$0{,}1 = \frac{1}{2} \alpha (0{,}1)^2$
$\alpha = 20$ rad/s²
$a = \alpha \cdot r$
$= 20 \cdot 0{,}02 = 0{,}4$ m/s²

c) Tegangan tali!

(m_1) $T_1 = m_1 \cdot a$
$= 6 \cdot 0{,}4$
$= 2{,}4$ N

(m_2) $T_2 = m_2 \cdot g - m_2 \cdot a$
$= 6 \cdot 9{,}8 - 6 \cdot 0{,}4$
$= 58{,}8 - 2{,}4$
$= 56{,}4$ //

(4)



$m = 3$ kg
$R = 10$ cm
$I = \frac{2}{3} m R^2$
Bola ditempatkan diam di titik A

Bola dilepaskan tanpa kecepatan awal & bergerak menggelinding tanpa slip pada lintasan ABC. Diketahui $g = 10$ m/s².

(a) Ek total bola saat berada di titik B

gerak menggelinding =D Gerak translasi + Gerak rotasi

K total $= K_T + K_r$
$\boxed{K\text{total} = \frac{1}{2} m v^2 + \frac{1}{2} I \omega^2}$

menggelinding → E. mekanik kekal
$EM_A = EM_B = EM_C$
$K_A + U_A = K_B + U_B = K_C + U_C$

(a) $EM_B = EM_A$
$K_B + U_B = K_A + U_A$
$K_B + mgh_B = \left(\frac{1}{2} m v_A^2 + \frac{1}{2} I \omega_A^2\right) + mgh_A$
(0, 0 "diam")

$K_B + (3 \times 10 \times \underbrace{10}_{V_B}) = (3 \times 10 \times 6)$

$K_B + 0 = 180$

$K_B = 180\ J$ //

(b) Kecepatan translasi pusat massa bola tsb saat ditiHU C!

$V_C = ?$

$\boxed{EM_C = EM_B}$

$K_C + U_C = K_B + U_B$

$\left(\frac{1}{2} M V_C^2 + \frac{1}{2} I \omega_C^2\right) + mgh_C = 180 + 0$

trik: ω ubah ke v

$\omega = \frac{V}{R} \rightarrow \omega^2 = \frac{V^2}{R^2}$

$\left(\frac{1}{2} m V_C^2 + \frac{1}{2}\left[\frac{2}{3} mR^2\right]\left[\frac{V_C^2}{R^2}\right]\right) + mgh_C = 180$

$\frac{1}{2} m V_C^2 + \frac{1}{3} m V_C^2 + mgh_C = 180$

$1{,}5 V_C^2 + 1 V_C^2 + (3 \cdot 10 \cdot 2) = 180$

$2{,}5 V_C^2 + 60 = 180$

$2{,}5 V_C^2 = 120$

$V_C^2 = \frac{120}{2{,}5}$

$V_C = \sqrt{\frac{120}{2{,}5}} = 6{,}92$ //

Besaran Fisika

Radian

Satuan (rad)

satuan rad

Hubungan satu rad:

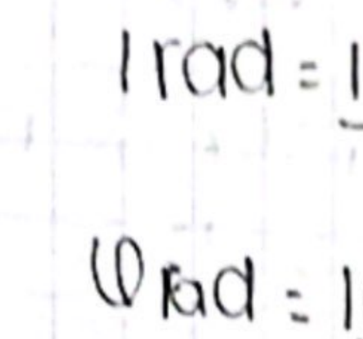
$180° = \pi$ rad

$1 \text{ rad} = \frac{180°}{\pi}$

$\theta_{Rad} = \frac{180\theta}{\pi}$ derajat

$\theta = \frac{\pi u}{180}$ radian

perpindahan sudut



perpindahan sudut/anguler

$(\Delta\theta) = \theta_2 - \theta_1$

(s) panjang lintasan:

panjang busur

$s = r\Delta\theta = r\theta$

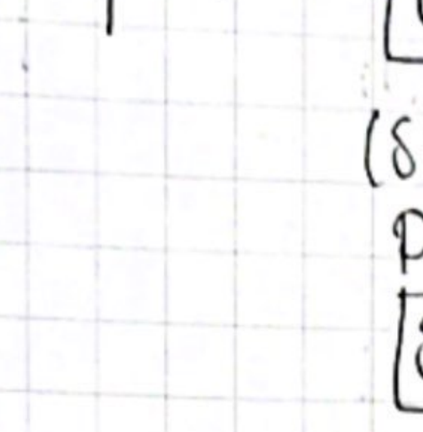
Satuan = $\Delta\theta$: rad

s = meter

(+) berlawanan jarum jam

(-) searah jarum jam

kecepatan sudut



Kecepatan sudut rata2

$\omega_{avg} = \frac{\text{Perpindahan}(\theta)}{\text{selang waktu}}$

$\omega_{avg} = \langle\omega\rangle = \frac{\theta_2 - \theta_1}{t_2 - t_1} = \frac{\Delta\theta}{\Delta t}$

kecepatan sudut sesaat = ω

$\Delta t \to 0$

$\omega = \lim_{\Delta t \to 0} \frac{\Delta\theta}{\Delta t} = \frac{d\theta}{dt}$

Satuan: rad/sekon $\left(\frac{rad}{s}\right)$

#hubungan kecepatan sudut (ω) dengan kecepatan linear (v)

$\boxed{v = r.\omega}$

$\boxed{\omega = \frac{v}{r}}$

$\frac{ds}{dt} = \frac{d(r\theta)}{dt}$

$\boxed{v = r\frac{d\theta}{dt} = r.\omega}$

$v = r.\omega$

$\boxed{\omega = \frac{v}{r}}$

Kecepatan sudut = rpm (rev/m)

$1 \text{ rpm} = \frac{1 \text{ revolution}}{1 \text{ minute}}$

$\boxed{1 \text{ rpm} = \frac{2\pi \text{ rad}}{60 \text{ sekon}}}$

Percepatan sudut rata²

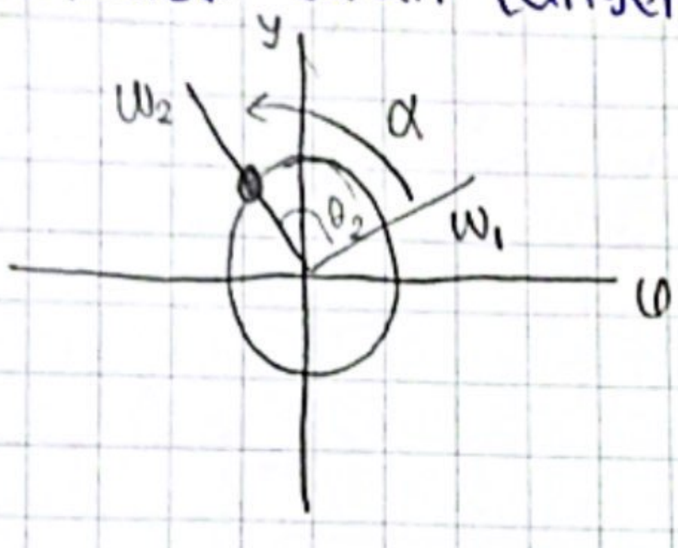
$$(\alpha_{avg}), (\alpha) : \frac{\Delta w}{\Delta t}$$

percepatan sudut sesaat :

"perc. sudut", α

$$\alpha = \lim_{\Delta t \to 0} \frac{\Delta w}{\Delta t} = \frac{dw}{dt} \quad (rad/s^2)$$

Percepatan arah tangensial & radial



⇒ Hubungan percepatan sudut dengan perc. linear "(α)

$$\frac{dv}{dt} = \frac{d(rw)}{dt}$$

$$\alpha = r \cdot \frac{dw}{dt} = r.a$$

$$a = r.\alpha$$

$$a = \frac{a}{r}$$

Komponen tangensial dari percepatan

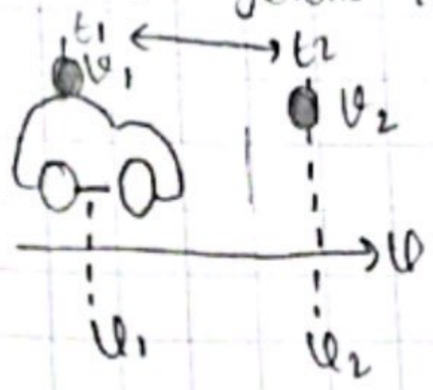
$$a_T = a_{sp} = \frac{v^2}{r} = w^2 . R$$

Percepatan total :

$$a_{total} = \sqrt{a_t^2 + a_r^2} = \sqrt{(ra)^2 + (w^2 r)^2}$$

Gerak rotasi dengan percepatan sudut konstan

kasus gerak translasi :



$$v_2 = v_1 + at \longrightarrow w_2 = w_1 + at$$

$$v_2 = v_1 + v_1 t + \frac{1}{2} at^2 \rightarrow \theta_2 = \theta_1 + w_1 t + \frac{1}{2} at^2$$

$$v_2^2 = v_1^2 + 2a\Delta v \longrightarrow w_2^2 = w_1^2 + 2a\Delta\theta$$

$$\Delta v = \frac{1}{2}(v_1 + v_2)t \longrightarrow \Delta\theta = \frac{1}{2}(w_1 + w_2)t$$

Energi kinetik rotasi

$$K = \frac{1}{2} mv^2 \longleftrightarrow K = \frac{1}{2} m(rw)^2$$

$$= \frac{1}{2} (mr^2) w^2$$

$$(mr^2) \quad K = \frac{1}{2} I w^2$$

satuan : Joule (J)

Dinamika gerak Rotasi

Benda Tegar

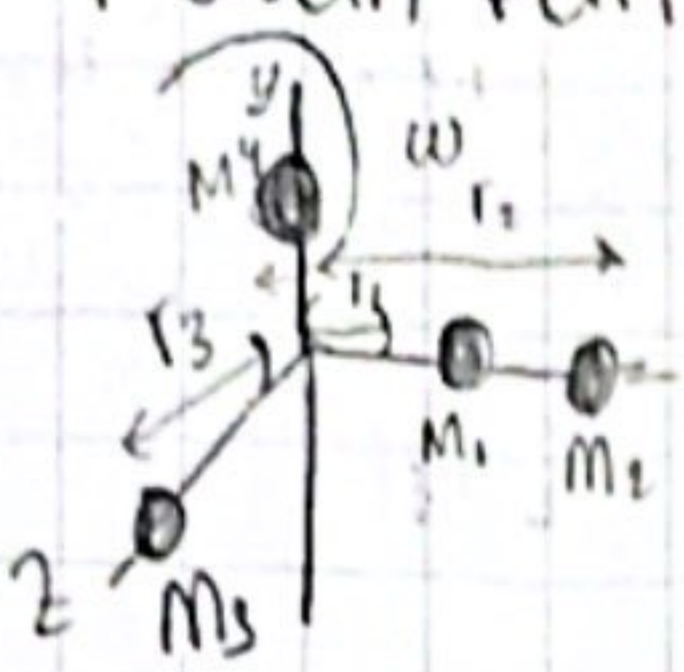
↳ Benda yang tidak mengalami deformasi atau perubahan

Secara formal, kumpulan partikel

Momen inersia benda diskrit

$I = m \cdot r^2$

4 buah partikel:



$I = m_1 r_1^2 + m_2 r_2^2 + m_3 r_3^2 + m_4 r_4^2$

m_4 terletak disumbu rotasi

$r_4 = 0$

Jika sistem terdiri dari N partikel, maka:

$I = m_1 r_1^2 + m_2 r_2^2 + m_3 r_3^2 + \dots + m_N r_N^2$

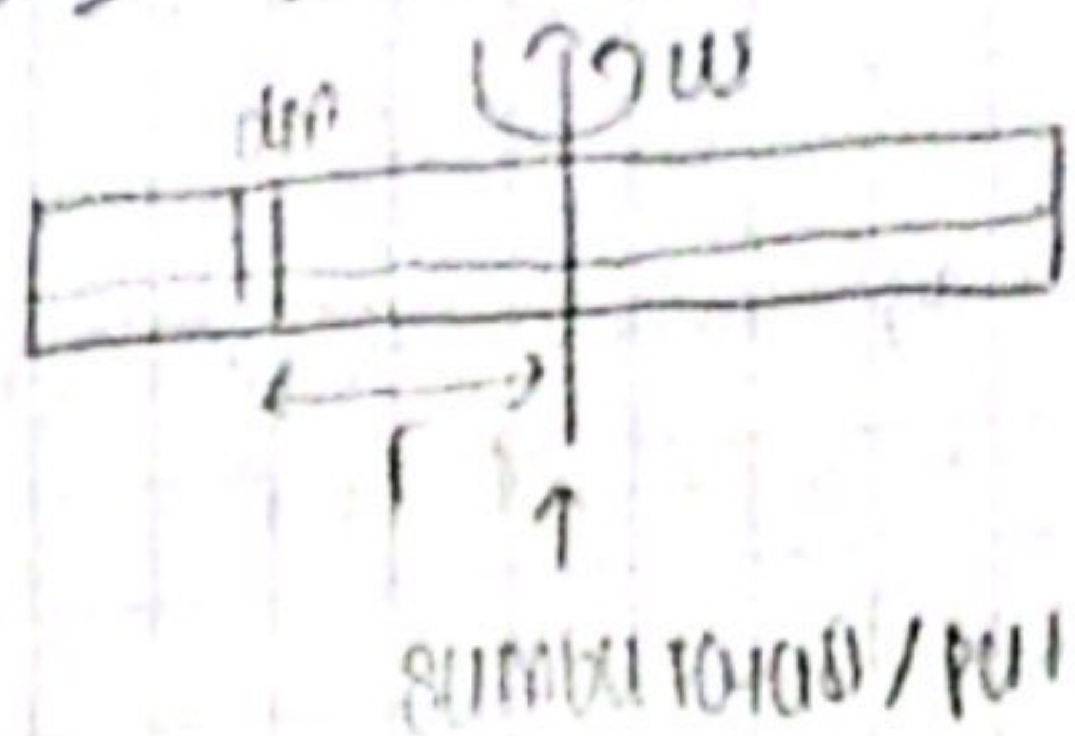
$I = \sum_{i=1}^{N} m_i \cdot r_i^2 = \int r^2 \, dm$

Satuan: $kg \cdot m^2$

Momen inersia benda kontinu

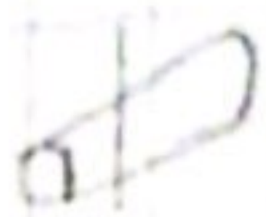
benda kontinu → kumpulan partikel

Partikel ditinjau dengan massa dm



Momen inersia Benda tegar:

1) Batang = $I_{pm} = \frac{1}{12} ML^2$



2) pelat = $I_{pm} = \frac{1}{12} M(a^2+b^2)$

3) Silinder berongga = $\frac{1}{2} M(R_1^2 + R_2^2)$

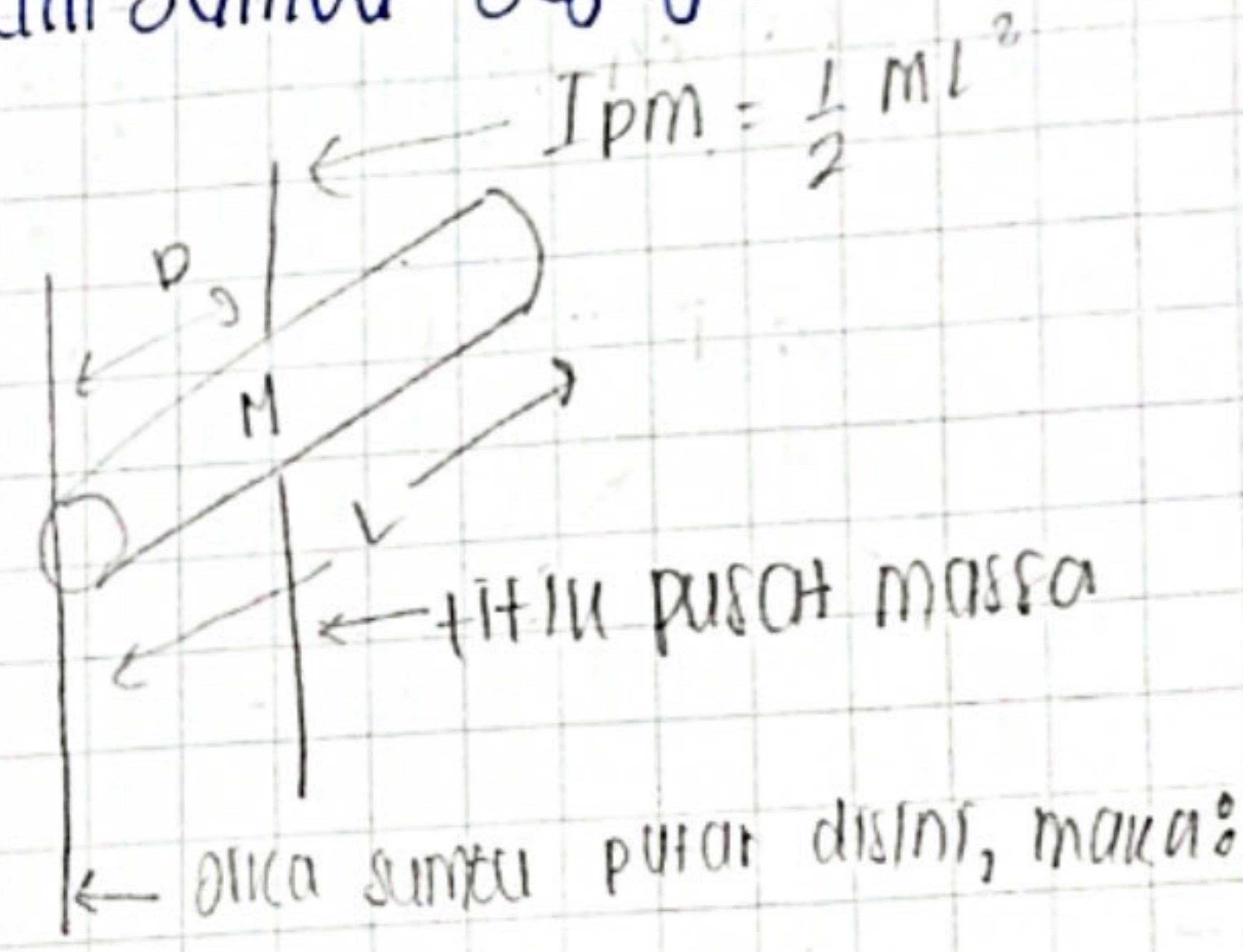
4) Silinder pejal = $I_{pm} = \frac{1}{2} MR^2$

5) Silinder berongga tipis = $I_{pm} = MR^2$

6) Bola pejal = $I_{pm} = \frac{2}{5} MR^2$ (Bola bowel)

7) Bola berongga tipis: $I_{pm} = \frac{2}{3} MR^2$ (Bola sepak)

Dalil Sumbu Sejajar *



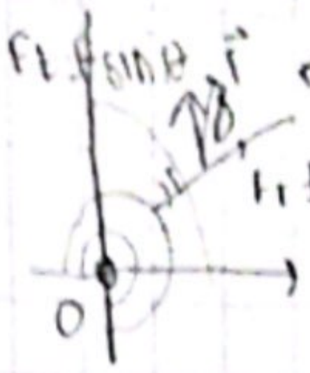
$I = I_{pm} + MD^2$

$= \frac{1}{12} ML^2 + M\left(\frac{1}{2} L\right)^2 = \frac{1}{12} ML^2 + \frac{1}{4} ML^2 = \frac{1}{3} ML^2$

torsi

terjadi perubahan gerak secara translasi

→ besar arah
→ posisi
→ skip soal



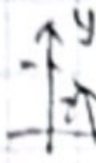
komponen gaya yang menyebabkan perubahan gerak rotasi (F_t)

momen gaya = $\tau = rF_t$

$\tau = (r)(F \sin\phi)$

satuan: N.M

ϕ adalah sudut vektor F & vektor r

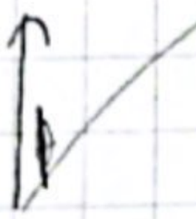


I:

Berlawanan arah → +τ

searah jarum jam → -τ

momen gaya sebagai vektor:



ingat perkalian silang vektor:

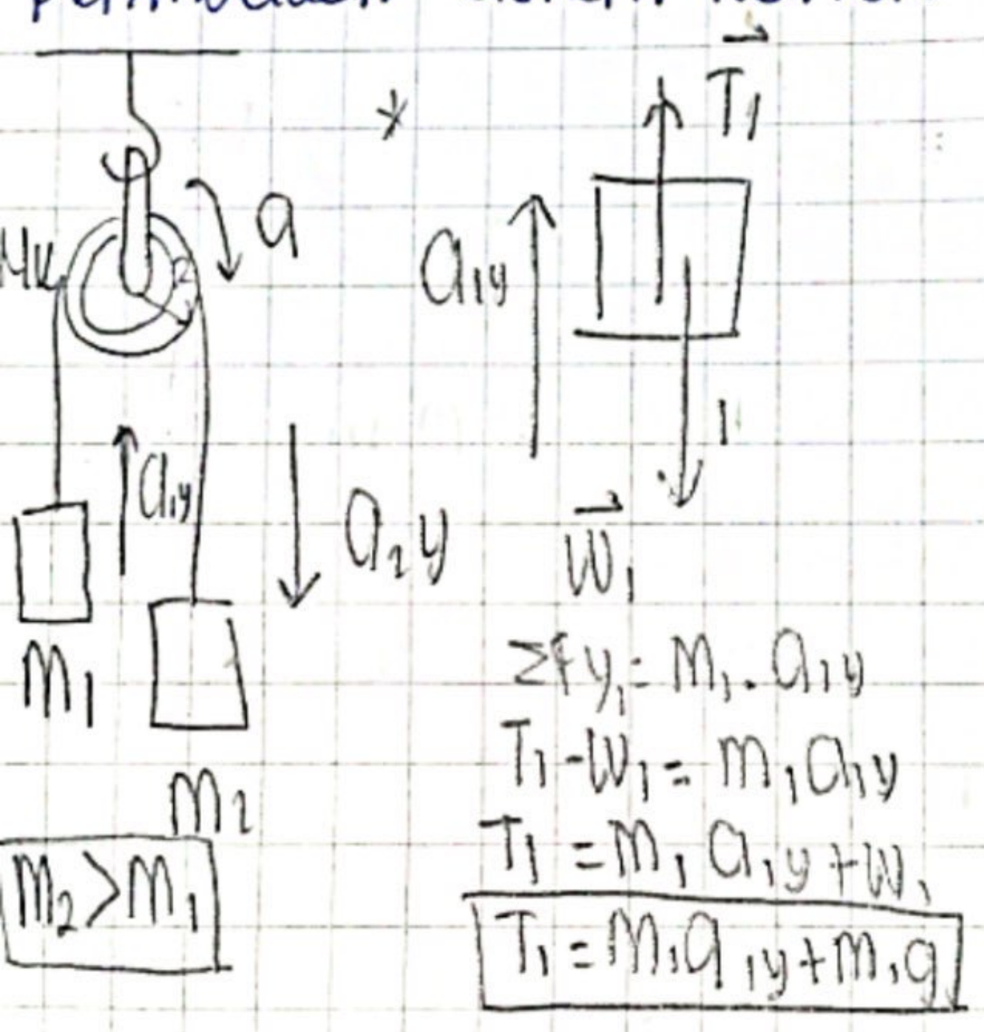
$\vec{r} \times \vec{F} = rF \sin\phi$

$\vec{\tau} = \vec{r} \times \vec{F}$

Hukum II Newton gerak rotasi

$\Sigma\tau = I.\alpha$

persamaan sistem katrol:



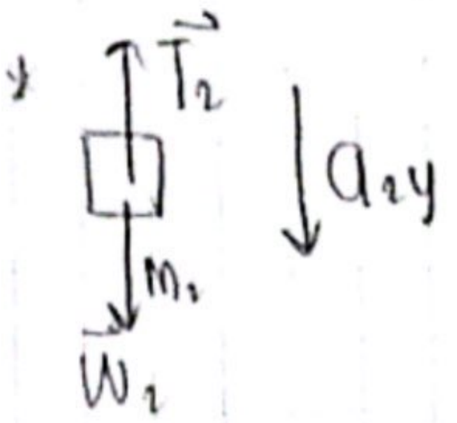
$m_2 > m_1$

$\Sigma F_{y_1} = m_1 . a_{1y}$

$T_1 - W_1 = m_1 a_{1y}$

$T_1 = m_1 a_{1y} + W_1$

$T_1 = m_1 a_{1y} + m_1 g$



$\Sigma F_{y_2} = m_2 . a_{2y}$

$-T_2 + W_2 = m_2 . a_{2y}$

$T_2 = W_2 - m_2 a_{2y}$

$T_2 = m_2 g - m_2 a_{2y}$

$\Sigma\tau = I_{pm} . \alpha$

$-T_1 R + T_2 R = I_{pm} \left(\frac{a}{R}\right)$

$(-T_1 + T_2) = \frac{I_{pm} a}{R^2}$

∴ 3 persamaan:

$T_1 = m_1 . a_{1y} + m_1 . g \ldots (1)$

$T_2 = m_2 . g - m_2 . a_{2y} \ldots (2)$

$(-T_1 + T_2) = \frac{I_{pm} \alpha}{R^2} \ldots (3)$

katrol berputar tanpa slip P_{12}

maka: $a_{1y} = a_{2y} = a$

substitusi persamaan (1) & (2) ke persamaan (3):

$(-m_1 a - m_1 g) + (m_2 g - m_2 a) = \frac{I_{pm} a}{R^2}$

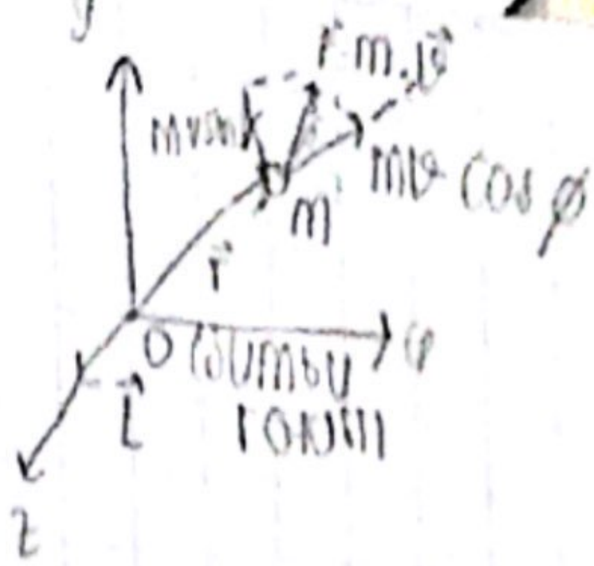
$\alpha = \frac{(m_2 - m_1) g}{\left(\frac{I_{pm}}{R^2} + m_1 + m_2\right)}$

momentum sudut partikel

$\vec{L} = \vec{r} \times \vec{P}$ ⇒ $\vec{P} = m . \vec{v}$

$\vec{L} = \vec{r} \times m\vec{v}$ ⇒ $L = mvr \sin\phi$

$L = m \times v \times r \times \sin\phi$ < besar mom. sdt



$$\frac{d\vec{p}}{dt} = \vec{F}_{net}$$

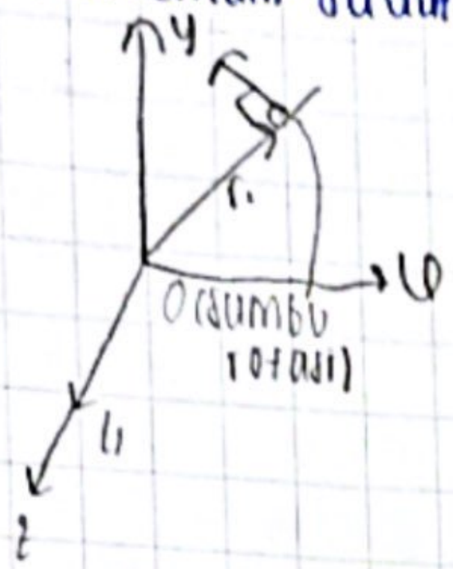
$$\frac{d\vec{L}}{dt} = \frac{d}{dt}(\vec{r} \times m\vec{v})$$

$$= \left(\frac{d\vec{r}}{dt} \times m\vec{v}\right) + \left(\vec{r} \times m.\frac{d\vec{v}}{dt}\right)$$

$$= (\vec{v} \times m\vec{v}) + (\vec{r} \times m.\vec{a})$$

$$\boxed{\frac{dL}{dt} = \vec{\tau}}$$

MOMENTUM sudut benda tegar



Besar momentum :

$$L_i = m_i . v_i . r_i \sin 90°$$
$$= m_i . (r_i w) r_i$$
$$= m_i r_i^2 w$$

$$\boxed{L = \sum L_i}$$

$$= (\sum m_i r_i^2) w$$

$$I = \sum m_i r_i^2$$

$$\boxed{L = Iw}$$

satuan : $kg.m^2.s^{-1}$

Kekekalan MOMENTUM sudut

$$\frac{dL}{dt} = \vec{\tau}$$

$\tau = 0 \rightarrow \frac{dL}{dt} = 0 \rightarrow L$: konstan

$$\boxed{L_{awal} = L_{akhir}}$$

$$(Iw)_{awal} = (Iw)_{akhir}$$

(11) Dua buah partikel $m_1 = 2$ kg & $m_2 = 4$ kg berada di bidang horizontal dengan masing-masing koordinat (-1,20 m, 0,50 m) & (0,60 m, -0,75 m) <Horizontal>

(a) Tentukan posisi koordinat x & y p/ partikel ketiga yang memiliki massa 3 kg supaya titik pusat massa seluruh partikel berada pada koordinat (-0,50 m, 0,0 m)

$$\Rightarrow X_{pm} = \frac{\sum (m_i . x_i)}{\sum m_i}$$

$$-0,50 = \frac{(2 . -1,20) + (4 . 0,60) + (3 . x_3)}{9}$$

$$-0,50 = \frac{-2,40 + 2,40 + 3x_2}{9}$$

$$-0,50 . 9 = 3x_3$$

$$-4,50 = 3x_3$$

$$x_3 = \frac{-4,50}{3} = -1,50$$

$$y_{pm} = \frac{\sum (m_i . y_i)}{\sum m_i}$$

$$-0,10 = \frac{(2 . 0,50) + (4 . -0,75)}{9}$$

$$-0,10 = \frac{1,00 - 3,00 + 3y_2}{9}$$

$$-0,10 . 9 = -2 + 3y_2$$

$$-6,3 + 2 = 3y_2$$

$$y_3 = \frac{-6,3 + 2}{3} = -1,43$$

(12) Gambar diatas adalah tampilan atas.

Bola → m = 300 g

menumbuk dinding → θ = 30°

v = 6 m/s.

jalu bola momentum & sudut sama

Bola mengalami kontak dengan dinding selama 10 ms. Dalam bentuk notasi vektor, tentukan:

(a) Impuls yang dialami bola akibat dinding!

$$\Rightarrow \vec{I} = \Delta \vec{P}$$

$$\boxed{I = m(v_{akhir} - v_{awal})}$$

$$v_x = v \cos\theta$$

$$v_y = v \sin\theta$$

$$+ v_{x,awal} = v \cos(30°)$$

$$v_{x,akhir} = -v \cos(30°)$$

Perubahan momentum

$$v_{Px} = m(v_{x akhir} - v_{x awal})$$

$$v_{Py} = m(v_{y akhir} - v_{y awal})$$

$$\Delta P_x = 0,3\,(-6 . \cos 30° = -6 . \cos(30°) = -3\sqrt{2}\ Ns$$

$$\Delta P_y = 0,3 . (6 . \sin(30°) - 6 . \sin(30°)) = 0$$

Besar impuls:

$$|I| = \sqrt{(\Delta P_x)^2 + (\Delta P_y)^2}$$

$$= \sqrt{(-3,12)^2 + 0^2} = 3,12\ Ns$$

(b) gaya rata² pada dinding

$$F_{rata\text{-}rata} = \frac{|I|}{\Delta t} = \frac{3,12\ Ns}{0,018} = 311,7\ N$$

(13) Sebuah peluru memiliki massa 5,20 g bergerak dengan v = 672 m/s & menabrak balok kayu bermassa 700 g yang diam diatas permukaan licin. Setelah peluru menembus balok & bergerak dengan arah sama, akibatnya v peluru ↓ = 428 m/s. Tentukan:

a. Besar kecepatan balok kayu setelah kembali peluru!

→ Kekekalan momentum:

$$m_p v_p + m_k . v_k = m_p . v_p' + m_k . v_k'$$

$$0,0052 . 672 + 0,1.0 = 0,0052 . 428 + 0,7 . v_k$$

$$3,4944 = 2,2256 + 0,7 . v_k$$

$$v_k = \frac{3,4944 - 2,2256}{0,7}$$

$$v_k = 1,81\ m/s$$

b. Berapa kecepatan pusat massa?

$$v_{cm} = \frac{(m_p . v_p) + (m_k . v_k)}{m_p + m_k}$$

$$= \frac{(5,20\,g . 672\ m/s) + (700\,g . 0)}{5,2\,g + 700\,g}$$

$$= 4,95519\ m/s$$

(14) Peristiwa tumbukan antara 2 partikel A & B dengan masing2 massanya 2 kg.
Dik: ϑ sebelum tumbukan $\vec{v}_A = (15\ m/s\ \hat{i} + 30\ m/s\ \hat{j})$

$\vec{v}_B = (-10\ m/s\ \hat{i} + 5\ m/s\ \hat{j})$

Setelah tumbukan kecepatan partikel A $\vec{v}_A = (-5\ m/s\ \hat{i} + 20\ m/s\ \hat{j})$

Tentukan: a) kec. akhir partikel B
b) Perubahan total energi kinetik kedua partikel

(a) $v'_{Bx} = 10\ m/s$
$v'_{By} = 15\ m/s$
$v_{akhir\ B}: \vec{v}_B = (10.0\hat{i} + 15.0\hat{j})\ m/s$

(b) $\Delta KE = KE_{akhir} - KE_{awal}$
$KE = \frac{1}{2} mv^2$

* $v_A = \sqrt{(15)^2 + (30)^2}$
$= \sqrt{225 + 900} = \sqrt{1125}$
$= 33,54\ m/s$

$KE_A = \frac{1}{2} m_A . v_A^2$
$= \frac{1}{2} . 2 . 33,54^2 = 1125\ J$

* $v_B = \sqrt{(-10)^2 + (5)^2}$
$= \sqrt{100 + 25} = \sqrt{125}$
$= 11,18\ m/s$

$KE_B = \frac{1}{2} . m_B . v_B^2$
$= \frac{1}{2} . 2 . 11,18^2$
$= 125\ J$

$\Sigma KE_{awal} = KE_A + KE_B$
$= 1125 + 125$
$= 1250\ J$

$KE_{awal} = KE_A + KE_B = 1125 + 125$
$= 1250\ J$

Energi kinetik akhir (KE akhir):
① Partikel A (akhir)

$v_A' = \sqrt{(-5)^2 + (20)^2}$
$= \sqrt{25 + 400}$
$= \sqrt{425} = 20,62\ m/s$

$KE_A' = \frac{1}{2} m_A . v_A'^2$
$= \frac{1}{2} . 2 . 20,62^2 = 425\ J$

hukum kekekalan momentum:

$m_A . v_A + m_B . v_B = m_A . v_A' + m_B . v_B'$

$m_A . v_{Ax} + m_B . v_{Bx} = m_A . v_A'_x + m_B . v_{Bx}'$

$m_A . v_{Ay} + m_B . v_{By} = m_A . v_A'_y + m_B . v_B'_y$

Kec. akhir partikel B?
(a) $\vec{v}_B = (v'_B x\ \hat{i} + v_B y\ \hat{j})$
→ komp x
$(2)(15) + (2)(-10) = (2)(-5) + (2)(v'_{Bx})$
$30 - 20 = -10 + 2v'_{Bx}$
$10 = -10 + 2v'_{Bx}$
$v'_{Bx} = 10\ m/s$

→ komp y
$(2)(30) + (2)(5) = (2)(20) + (2)(v'_{By})$
$60 + 10 = 40 + 2 . v'_{By}$
$70 = 40 + 2 . v'_{By}$
$70 = 40 + 2 . v'_{By}$
$v'_{By} = 15\ m/s$

$\therefore \vec{v}_B = (10\hat{i} + 15\hat{j})\ m/s$

② Partikel B (akhir):
$v_B' = \sqrt{(10)^2 + (15)^2}$
$= \sqrt{100 + 225} = \sqrt{325} = 18,03\ m/s$

$KE_B' = \frac{1}{2} m_B . v_B'^2$
$= \frac{1}{2} (2) (18,03)^2$
$= 325\ J$

KE total akhir = $KE_{awal} - KE_{akhir}$
$= 750 - 1250$
$= -500\ J$

Selisih energinya hilang

(15) Massa 1 = 2 kg → kelajuan $v = 10\ m/s$
Massa 2 = 5 kg → kelajuan $v = 3\ m/s$
kedua balok bergerak di permukaan licin
Balok 2 punya pegas & ujung pegasnya: 1120 N/m.
Saat balok bertumbukan, pegas mengalami pemampatan maksimum & kedua balok punya kec. sama.
Tentukan besar kompresi max yg dialami pegas!

hukum kekekalan <momentum>

$m_1.v_1 + m_2.v_2 = (m_1+m_2).V$

$m_1 = 2\ kg$, $V_1 = 10\ m/s$

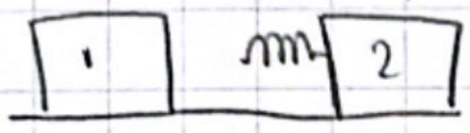
$m_2 = 5\ kg$, $V_2 = 3\ m/s$

$(20) + (5 \mid 3) = (2+5).V$

$20 \mid 15 = (7).V$

$35 = 7V$

kecepatan bersama <mau> $\longrightarrow V = \frac{35}{7} = 5\ m/s$



hkm. kekekalan E. Mekanik =

Eawal = Eakhir

$\frac{1}{2} m_1.v_1^2 + \frac{1}{2} m_2.v_1^2 = \frac{1}{2} (m_1+m_2)V' + \frac{1}{2} kx^2$

$\frac{1}{2} 2.10^2 + \frac{1}{2} 5.3^2 = \frac{1}{2} (7) 5^2$

$100 + 22,5 = 87,5 ?$

kekekalan energi =

$100 + 22,5 = 87,5 + \frac{1}{2}(1120)x^2$

$122,5 - 87,5 = 560\ x^2$

$35 = 560\ x^2$

$x^2 = \frac{35}{560}$

$x^2 = 0,0625$

$x = \sqrt{0,0625}$

$= 0,25\ m$

$= 25\ cm$