Solusi Tutorial 2 Fisika Dasar 1A ITB

oleh : Wawan K

A. PERTANYAAN

①

a) Jawab : (2), (3), dan (4)

Bukti :

- untuk situasi 1

$$\Sigma F_x = 5 - 5 = 0$$

- untuk situasi 2

$$\Sigma F_x = 3 - 2 = 1\ N$$

- untuk situasi 3

$$\Sigma F_x = 5 - 4 = 1\ N$$

- untuk situasi 4

$$\Sigma F_x = 3 - 5 = -2N$$

b) Jawab : 1, 3, 4

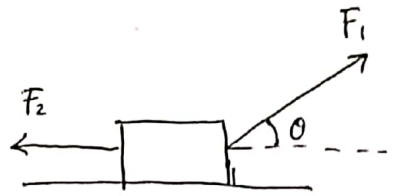
Penjelasan : (i) Situasi 1 : $\Sigma F_y = 7 - 4 = 3N$

(ii) situasi 2 : $\Sigma F_y = 6 - 6 = 0$

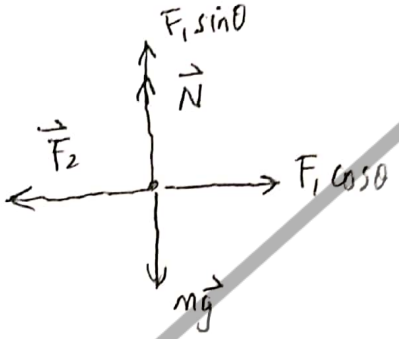
(iii) situasi 3 : $\Sigma F_y = 6 - 7 = -1N$

(iv) Situasi 4 : $\Sigma F_y = 5 - 9 = -4\ N$

(2)



-) $\theta \rightarrow$ dikurangi kita gambarkan diagram benda bebas.



-) Benda bergerak dalam arah x, dengan V konstan

maka : $\Sigma F = ma$

$$F_1 \cos\theta - F_2 = 0$$

$$F_1 \cos\theta = F_2$$

-) jika θ dikurangi $\rightarrow$ maka $\cos\theta \rightarrow$ nilainya membesar, dengan F_1 konstan, sehingga F_2 harus diperbesar

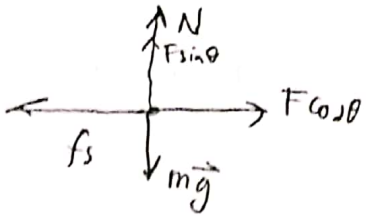
(3) Jawaban : 1. grafik a dan e

2. grafik b dan d

3. grafik b dan f

4. grafik c dan f

④



Jika θ bertambah,

a) $F_x = F\cos\theta$ — θ bertambah maka cosθ mengecil

↘ mengecil

Jadi, F_x berkurang

b) f_s → gaya gesek statis

$\Sigma F_x = 0$

$F\cos\theta - f_s = 0$

$f_s = F\cos\theta$

berkurang,

Sehingga f_s akan berkurang

c) $\Sigma F_y = 0$

$N + F\sin\theta - mg = 0$

$N = mg + F\sin\theta$

↓

θ bertambah → $\sin\theta$ → membesar

Jadi, N → bertambah

d) $f_{s\,max}$ = benda tepat akan bergerak

$f_{s\,max} = \mu_s \cdot N$

↓ bertambah

$f_{s\,max}$ ⇒ bertambah

karena N [illegible],

→ bertambah

(5)

Lintasan 1 jari-jari = 3R

Lintasan 2 jari-jarinya = 3R

Lintasan 3 jari-jarinya = 2R

Lintasan 4 jari-jarinya = R

Lintasan 5 jari-jarinya = 3R

Karena lintasan melengkung, maka

$$F_{sp} = \frac{mv^2}{R} \sim F_{sp} \sim \frac{1}{R}$$

Jadi urutan gaya dari yang terbesar,

4, 2, 1, 2 dan 5 sama.

oleh: Wawan K

B. SOAL

① a) Dalam kasus pertama

$$\vec{F}_1 + \vec{F}_2 = \left[(3\hat{i}+4\hat{j})N + (-3\hat{i}) + (-4\hat{j})N \right] = 0$$

Jadi $a = 0$

b) Dalam kasus kedua,

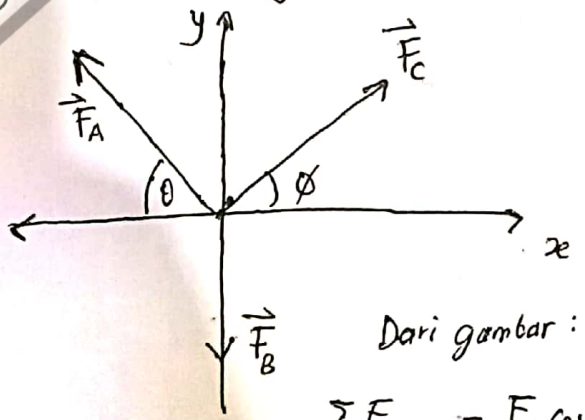
$$\vec{a} = \frac{\vec{F}_1 + \vec{F}_2}{m} = \frac{(3\hat{i}+4\hat{j})N + (-3\hat{i}+4\hat{j})N}{2\,kg}$$

$$\vec{a} = 4\ m/s^2\ \hat{j}$$

c) Dalam situasi terakhir,

$$\vec{a} = \frac{\vec{F}_1 + \vec{F}_2}{m} = \frac{\left((3\hat{i}+4\hat{j})N + (3\hat{i}-4\hat{j})N\right)}{2\,kg} = 3\ m/s^2\ \hat{i}$$

② Kita gambarkan digram benda bebas nya,



Gaya netto harus nol.

$$F_{neto} = \vec{F}_A + \vec{F}_B + \vec{F}_C = 0$$

Dari gambar :

$$\Sigma F_{x\,net} = F_C \cos\phi - F_A \cos\theta = 0$$

$$\Sigma F_{y\,net} = F_A \sin\theta + F_C \sin\phi - F_B = 0$$

(2) untuk menyelesaikan F_B pertama kita hitung ϕ dengan $F_A = 220N$, $F_C = 170N$ dan $\theta = 47°$, maka kita dapatkan.

$$\cos\phi = \frac{F_A \cos\theta}{F_C} = \frac{(220)\cos 47°}{170N} = 0{,}883 \Rightarrow \phi = 28°$$

Substitusi nilai ini ke persamaan (2), maka :

$$F_B = F_A \sin\theta + F_C \sin\phi = 220N \sin 47° + (170N) \sin 28° = 241N$$

(3) a) percepatan adalah turunan dua kali dari fungsi posisi, dan gaya dpt kita tulis $\vec{F} = m\vec{a}$, sehingga kita cari a terlebih dahulu,

a) untuk arah x

$$\vec{V} = \frac{d\vec{x}}{dt} = \frac{d}{dt}\left(-15 + 2t + 4t^3\right)$$

$$\vec{V} = 2 - 12t^2$$

$$\vec{a} = \frac{dV}{dt} = \frac{d^2x}{dt^2} = -24t \ m/s^2 \ \hat{i}$$

a) untuk arah y

$$\vec{V} = \frac{dy}{dt} = 7 - 18t$$

$$\vec{a} = \frac{d\vec{V}}{dt} = \frac{d^2y}{dt^2} = -18 \ m/s^2 \ \hat{j}$$

(3) c) Pada $t = 0{,}7\,s$, kita mempunyai

$$V(t = 0{,}7s) = (-3{,}88\ m/s)\hat{i} + (-5{,}60\ m/s)\hat{j}$$

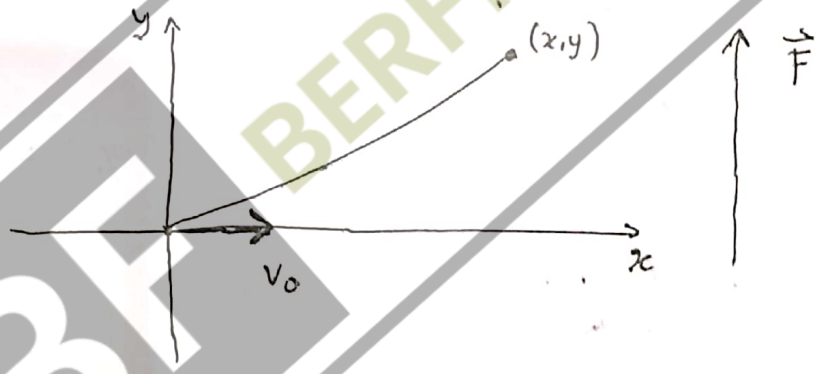
Sehingga sudut yang dibentuk V terhadap $x+$, adalah :

$$\theta_v = \tan^{-1}\left(\frac{V_y}{V_x}\right)$$

$$= \tan^{-1}\left(\frac{-5{,}60\ m/s}{-3{,}88\ m/s}\right) = 55{,}3^\circ \text{ atau } -125^\circ$$

kita pilih (-125°) karena $\vec{v}$ berada dalam kuadran ketiga

(4) Pergerakan elektron dapat kita gambar,



karena

Gaya dan percepatan konstan; dan gerakan dalam dua arah, maka

$x = V_{0x}t$ dan $y = V_{0y}t + \frac{1}{2}at^2$

$\downarrow$

$y = \frac{1}{2}at^2$

$t = \frac{x}{V_0}$

$y = \frac{1}{2}\left(\frac{F}{m}\right)t^2$

Sehingga $y = \frac{1}{2}\frac{F}{m}\left(\frac{x}{V_0}\right)^2 = \frac{1}{2}\left(\frac{4{,}5\times10^{-16}}{9{,}1\times10^{-31}} \times \left(\frac{30\times10^{-3}}{1{,}2\times10^{7}}\right)^2 = 1{,}5\times10^{-3}\ m\right.$

a) Percepatan nya adalah :

$$\vec{a} = a_x \hat{i} + a_y \hat{j}$$

$$= \frac{d^2x}{dt^2}\hat{i} + \frac{d^2y}{dt^2}\hat{j}$$

$$\vec{a} = -24t\,\hat{i} - 18\,\hat{j} \quad m/s^2$$

Pada saat $t = 7s$, kita mempunyai,

$$\vec{a} = (-16,8)\hat{i} - 18\hat{j} \quad m/s^2$$

dengan besarnya

$$\vec{a} = |\vec{a}| = \sqrt{(-16,8)^2 + (-18)^2}$$

$$|\vec{a}| = 24,6 \ m/s^2$$

Besar gayanya adalah : $F = ma = (0,34\,kg)(24,6\ m/s^2) = 8,37\ N$

b) Sudut $\vec{F}$ atau $\vec{a} = \frac{\vec{F}}{m}$ terhadap sumbu $x+$ adalah

$$\theta = \tan^{-1}\left(\frac{a_y}{a_x}\right) = \tan^{-1}\left(\frac{-18\ m/s^2}{-16\ m/s^2}\right) = 47^\circ \text{ atau } -133^\circ$$

Kita pilih (-133°) karena F berada dalam kuadran ketiga.

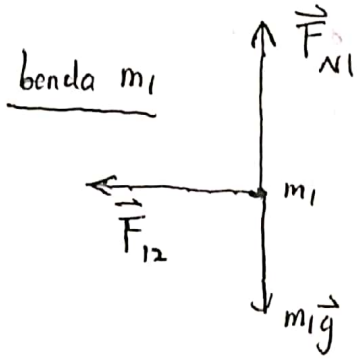
c) Arah dari gerakan adalah arah dari tangensial lintasan, yaitu arah dari vektor kecepatan.

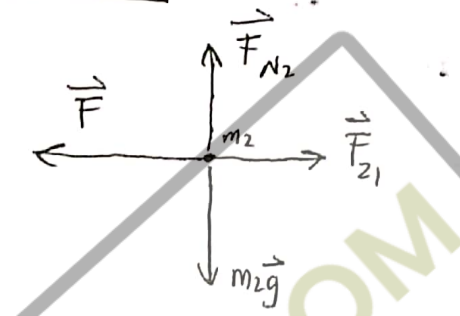
$$V(t) = V_x\hat{i} + V_y\,\hat{j} = \frac{dx}{dt}\hat{i} + \frac{dy}{dt}\hat{j}$$

$$\vec{V}(t) = (2 - 12t^2)\hat{i} + (7 - 18t)\hat{j}$$

(5) a) $$F_{21} = F_{12} = \left(\frac{m_2}{m_1+m_2}\right)F = \left(\frac{1{,}2\ kg}{2{,}3\ kg + 1{,}2\ kg}\right)(3{,}2\ N) = 1{,}1\ N$$

b) Jika F diterapkan pada sebaliknya, maka diagram benda bebas nya,





Dengan menuliskan persamaan hukum Newton kedua,

m_1 :

$$\Sigma F_x = m_1 a$$

$$-F_{12} = m_1(-a)$$

$$F_{12} = m_1 a \quad \text{----1)}$$

$$a = \frac{F_{12}}{m_1}$$

m_2

$$-F + F_{21} = m_2(-a)$$

$$-F_{21} + F = m_2 a$$

$$F - F_{21} = m_2 a \quad \text{----2)}$$

Substitusi pers (1) ke pers (2),

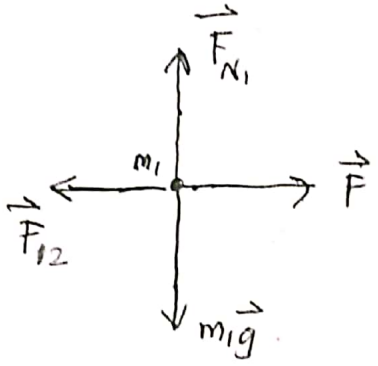
$$F - F_{21} = m_2\left(\frac{F_{12}}{m_1}\right)$$

$$F = F_{21}\left(1 + \frac{m_2}{m_1}\right)$$

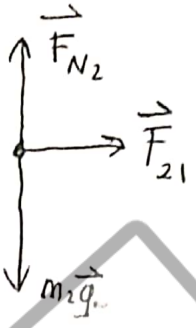
$$F_{21} = F_{12} = \left(\frac{m_1}{m_1+m_2}\right)F = \frac{2{,}3}{2{,}3+1{,}2}(3{,}2) = 2{,}1\ N$$

(5) Diagram benda bebas kedua benda,

Benda m_1



Benda m_2



•) karena aksi reaksi, maka :

$\vec{F}_{12} = -\vec{F}_{21}$

$\vec{F}_{12} = \vec{F}_{\text{pada 1 oleh 2}}$

$\vec{F}_{21} = \vec{F}_{\text{pada 2 oleh 1}}$

} pasangan aksi reaksi, besarnya sama dan berlawanan arah

a) Pada balok 1

$\Sigma F_x = m_1 a$

$\vec{F} - \vec{F}_{12} = m_1 \vec{a}$ ..... 1)

• Pada balok 2

$\Sigma F_x = m_2 a$

$\vec{F}_{21} = m_2 \vec{a}$ ..... 2)

a) Dari persamaan kedua, kita peroleh

$a = \frac{F_{21}}{m_2}$, substitusi ke pers (1),

maka $F - F_{12} = m_1 \left(\frac{F_{21}}{m_2}\right)$ karena $F_{12} = F_{21}$, maka :

$F_{12} + m_1 \left(\frac{F_{12}}{m_2}\right) = F$

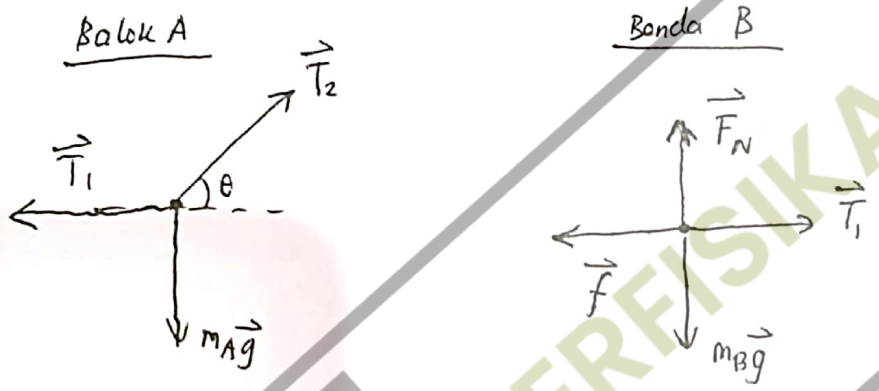
$F_{12} \left(1 + \frac{m_1}{m_2}\right) = F \rightarrow F_{21} = F_{12} = \left(\frac{m_2}{m_1 + m_2}\right) F$

(5) b) Kenapa F_{kontak} kasus (a) < F_{kontak} kasus (b)

Karena $m_1 > m_2$, sehingga untuk menggeser benda m_2 dari m_1 ke F yang diperlukan lebih kecil dibandingkan menggeser dari m_2 ke m_1

Jadi jelas.

(6) Gambar diagram bebas untuk balok A dan balok B



Kita terapkan hukum Newton I :

Balok A

$\Sigma F_x = 0$

$T_2 \cos\theta - T_1 = 0 \rightarrow T_2 = \frac{T_1}{\cos\theta}$

$\Sigma F_y = 0$

$T_2 \sin\theta - W_A = 0$

Balok B

$N_B = W_B$

$\Sigma F_x = 0$

$T_1 - f_{s\,max} = 0 \rightarrow T_1 = \mu_s W_B$

$\Sigma F_y = 0$

$F_N - W_B = 0$

$W_A = T_2 \sin\theta$,

$W_A = \frac{T_1}{\cos\theta} \cdot \sin\theta = \mu_s W_B \tan\theta$

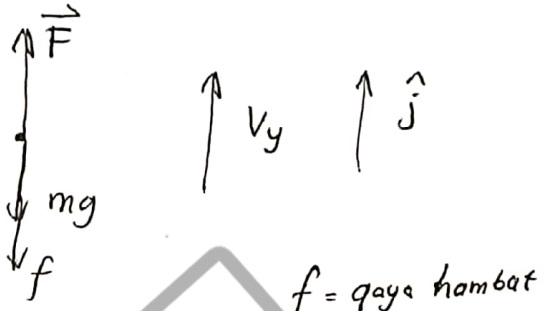
$= 0{,}25\ (711\,N) \tan 30^\circ$

$W_A = 103\,N \approx 1 \times 10^2\,N$ //

(7) Lebah mengalami tiga keadaan gerak,

(1) Bergerak ke atas

$$\Sigma F_y = m\frac{dV_y}{dt}$$



f = gaya hambat

$f = -\beta V_y$

$$F - mg - \beta V_y = m\frac{dV_y}{dt}$$

$$\frac{dV_y}{F - mg - \beta V_y} = \frac{1}{m}dt$$

misalkan $U = F - mg - \beta V_y$, maka

$$dU = -\beta\, dV_y,$$

$$dV_y = -\frac{1}{\beta}dU$$

Sehingga: $-\frac{1}{\beta}\frac{dU}{U} = \frac{1}{m}dt \rightarrow \int_{U_0}^{U}\frac{dU}{U} = -\frac{\beta}{m}\int_0^t dt$

$$\ln\left(\frac{U}{U_0}\right) = -\frac{\beta}{m}t$$

$$U = U_0 e^{-(\beta/m)t}$$

Saat awal $\rightarrow V_y(0) = 0$

kita ganti U dan U_0 sehingga: $F - mg - \beta V_y(t) = (F - mg)e^{-\frac{\beta}{m}t}$

$$\beta V_y(t) = F - mg\left(1 - e^{-\frac{\beta}{m}t}\right)$$

$$V_y(t) = \frac{F - mg}{\beta}\left(1 - e^{-\beta/m\, t}\right) \quad \text{---- 1)}$$

(7) misalkan $U = F + mg - \beta V_y$

$du = -\beta\, dy \rightarrow dV_y = -\frac{1}{\beta} du$, dengan $V_y(0) = 0$

maka : $-\frac{1}{\beta}\frac{du}{u} = \frac{1}{m} dt$

$$\int_{u_0}^{u} \frac{du}{u} = -\frac{\beta}{m}\int_0^t dt$$

$$\ln\left(\frac{F + mg - \beta V_y(t)}{F + mg}\right) = -\frac{\beta}{m} t$$

$$F + mg - \beta V_y(t) = (F + mg)\, e^{-\frac{\beta}{m} t}$$

$$V_y(t) = \frac{1}{\beta}\left(F + mg\right)\left(1 - e^{-\frac{\beta}{m} t}\right)$$

Saat V_y max → jika $\frac{dV_y}{dt} = 0$

Sehingga :

$$\frac{dV_y}{dt} = \frac{F + mg}{\beta}\left(0 + \frac{\beta}{m} e^{-\frac{\beta}{m} t}\right) = 0$$

$$\frac{F + mg}{\beta}\underbrace{\left(\frac{\beta}{m} e^{-\frac{\beta}{m} t}\right)}_{=0} = 0$$

$e^{-\frac{\beta}{m} t} = 0$ saat $t \rightarrow \infty$

Sehingga $V_2 = \frac{F + mg}{\beta} \rightarrow F + mg = \beta V_2$ .... (3)

(7)

Saat $V_{y\,max} = V_1$ jika $\frac{dV_y}{dt} = 0$

maka $\frac{dV_y}{dt} = \frac{F - mg}{\beta}\left(0 + \frac{\beta}{m} e^{-\frac{\beta}{m}t}\right) = 0$

$$\frac{F - mg}{\beta}\left(\frac{\beta}{m}\right)\underbrace{e^{-\frac{\beta}{m}t}}_{=0} = 0$$

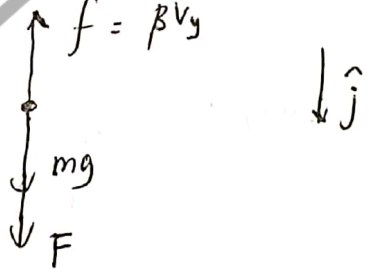
Solusinya : $e^{-\beta/m\,t} = 0 \rightarrow$ saat $t \rightarrow \infty$

Sehingga, $V_1 = \frac{F - mg}{\beta}$

$$\beta = \frac{F - mg}{V_1}$$

atau $F - mg = \beta V_1$ .... 2)

- Saat bergerak ke bawah



maka persamaan geraknya :

$$F + mg - \beta V_y = m\frac{dV_y}{dt}$$

$$\frac{dV_y}{F + mg - \beta V_y} = \frac{1}{m}dt$$

(7) •) pers (2) dan pers (3) kita tambahkan

$$F - mg = \beta V_1$$

$$\underline{F + mg = \beta V_2} \; +$$

$$2F = \beta (V_1 + V_2)$$

$$\beta = \frac{2F}{V_1 + V_2} \quad \ldots\ldots (4)$$

•) pers (2) dan (3) kita kurangkan

$$F + mg = \beta V_2$$

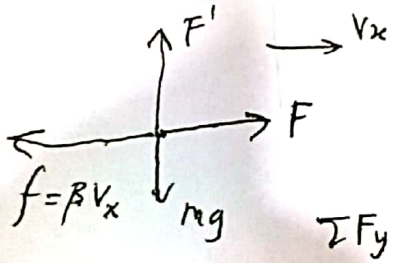
$$F - mg = \beta V_1$$

$$2mg = \beta (V_2 - V_1)$$

$$mg = \frac{\beta}{2} (V_2 - V_1)$$

$$mg = \frac{F}{V_1 + V_2} (V_2 - V_1)$$

•) Saat bergerak horizontal



$$\Sigma F_x = m \frac{dV_x}{dt}$$

$$\Sigma F_y = 0$$

$$F' - mg = 0$$

$$F' = mg$$

$$F - \beta V_x = m \frac{dV_x}{dt}$$

$$\frac{dV_x}{F - \beta V_x} = \frac{1}{m} dt \rightarrow$$

(7) misalkan $U = F - \beta x$

$$dU = -\beta\, dx \rightarrow dx = -\frac{1}{\beta} du$$

Sehingga :

$$\int_{U_0}^{U} \frac{du}{U} = -\frac{\beta}{m} \int_{0}^{t} dt$$

$$F - \beta V_x(t) = F e^{-(\beta/m)t}$$

$$V_x = \frac{1}{\beta} F \left(1 - e^{-\frac{\beta}{m} t}\right)$$

V_x maksimum saat $\frac{dV_x}{dt} = 0 = \frac{F}{\beta}\left(0 + \frac{\beta}{m} e^{-\frac{\beta}{m} t}\right)$

$$\frac{dV_x}{dt} = 0 \rightarrow \frac{F}{m} e^{-\frac{\beta}{m} t} = 0$$

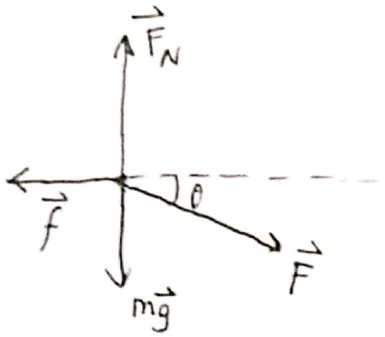
$e^{-\frac{\beta}{m} t} = 0 \rightarrow$ saat $t \rightarrow \infty$

Sehingga :

$$V_{x\,max} = \frac{F}{\beta} = \frac{F}{\frac{2F}{(V_1 + V_2)}} = \frac{V_1 + V_2}{2}$$

Jadi $\boxed{V_{x\,max} = \frac{V_1 + V_2}{2}}$

(8) Gambar diagram benda bebasnya, adalah :



dengan menerapkan hukum Newton kedua,

$$\Sigma F_x = ma$$

$$F_x = F\cos\theta - f = ma \quad \cdots (1)$$

$$F_y = F_N - F\sin\theta = 0 \quad \cdots (2)$$

karena $f = \mu_k F_N \rightarrow$ maka $F_N = mg + F\sin\theta$, menghasilkan

$f = \mu_k (mg + F\sin\theta)$, substitusi f ke pers (1)

$$F\cos\theta - \mu_k (mg + F\sin\theta) = ma$$

$$a = \frac{F}{m}(\cos\theta - \mu_k \sin\theta) - \mu_k g$$

- Jika kita lihat gambar, $a = 3\ m/s^2$, ketika $\mu_k = 0$, maka :

$$3\ m/s^2 = \frac{F}{m}\cos\theta$$

- kita juga temukan $a = 0$ ketika $\mu_k = 0{,}20$

Sehingga : $$0 = \frac{F}{m}\left(\cos\theta - (0{,}20)\sin\theta - 0{,}20(9{,}8)\right)$$

$$0 = 3 - 0{,}2\frac{F}{m}\sin\theta - 1{,}96 = 1{,}04 - 0{,}20\frac{F}{m}\sin\theta$$

(8) menghasilkan

$$\frac{F}{m}\sin\theta = 5{,}2 \ m/s^2$$

dengan menghombinasi kedua hasil, maka

$$5{,}2 = \frac{F}{m}\sin\theta$$

$$3 = \frac{F}{m}\cos\theta$$

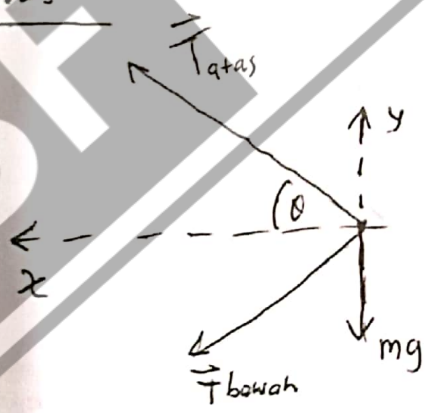
$$\frac{5{,}2}{3} = \tan\theta$$

$$\tan\theta = \left(\frac{5{,}2 \ m/s^2}{3 \ m/s^2}\right)$$

$$\tan\theta = 1{,}73$$

$$\boxed{\theta = 60^\circ}$$

(9) Diagram benda bebas



Besar percepatan

$$a = \frac{v^2}{R}$$

arah gerak x

$$\Sigma F_x = ma$$

$$T_A\cos\theta + T_B\cos\theta = \frac{mv^2}{R}$$

arah gerak y

$$\Sigma F_y = 0$$

$$T_A\sin\theta - T_B\sin\theta - mg = 0$$

(9) a) Persamaan (2) dapat kita peroleh

$$T_B = T_A - \frac{mg}{\sin\theta}$$, karena $\theta = 30^\circ$ maka

$$T_{bawah} = 35\,N - \frac{(1{,}34)(9{,}8)}{\sin 30^\circ} = 8{,}74\,N$$

b) gaya F_{neto} yang bekerja pada bola :

$$F_{neto} = \left(T_{atas} + T_{bawah}\right)\cos\theta$$

$$= (35\,N + 8{,}74\,N)\cos 30^\circ$$

$$F_{neto} = 37{,}9\,N$$

c) Laju bola

Jari-jari lintasan, $R = (1{,}70/2)\tan 30^\circ = 1{,}47\,m$

maka : $F_{neto} = \frac{mv^2}{R}$

$$v = \sqrt{\frac{R\,F_{neto}}{m}} = \sqrt{\frac{(1{,}47)(37{,}9)}{1{,}34}} = 6{,}45\ m/s$$

d) arah F_{neto} adalah kekiri (berarah kedalam secara radial)

(10)

a) $R = \frac{0,94}{2\pi} = 0,15\ m$

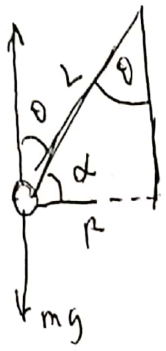


Diagram bebas benda

Sehingga $\cos\alpha = \frac{R}{L}$

$\alpha = \cos^{-1}\left(\frac{R}{L}\right)$

$\alpha = \cos^{-1}\left(\frac{0,15\ m}{0,90\ m}\right)$

$\alpha = 80°$

arah sumbu y $\quad \Sigma F_y = 0$

$T\sin\alpha - mg = 0$

$T = \frac{mg}{\sin\alpha} = \frac{0,040\ (9,8)}{\sin(80°)} = 0,40N$

b)

arah sumbu x

$\Sigma F_x = \frac{mV^2}{R}$

$T\cos\alpha = \frac{mv^2}{R}$

$V^2 = \frac{TR\cos\alpha}{m} = \frac{0,40\ (0,15)\cos 80°}{0,040} =$

$V = 0,49\ s$

Jadi, periode gerakan bandul

$T = t = \frac{S}{V} = \frac{0,94\ m}{0,49\ s} = 1,9\ s$