Solusi Lembar Tugas Mahasiswa ke-1
Fisika Dasar IA (FI-1101)

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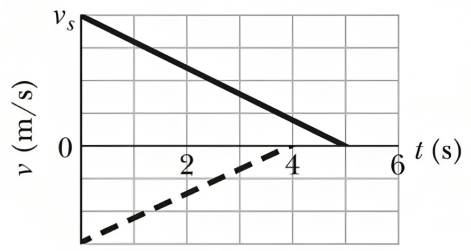
1. As two trains move along a track, their conductors suddenly notice that they are headed toward each other. The figure gives their velocities v as functions of time t as the conductors slow the trains. The figure's vertical scaling is set by $v_s = 40,0\ m/s$. The slowing processes begin when the trains are $200\ m$ apart. What is their separation when both trains have stopped?



Materi: Kinematika

➢ *Gerak Lurus Beraturan*

$$s = V \cdot t$$

➢ *Gerak Lurus Berubah Beraturan*

$$V_t = V_0 + at \qquad s = V_t \cdot t - \frac{1}{2}at^2$$

$$s = V_0 \cdot t + \frac{1}{2}at^2 \qquad s = \left(\frac{V_t - V_0}{2}\right) \cdot t$$

$$V_t{}^2 = V_0{}^2 + 2as$$

Diketahui:

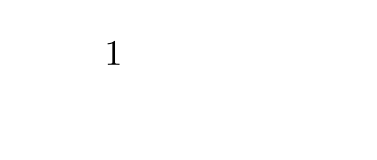
$$v_s = 40\ m/s \qquad d = 200\ m$$

Ditanya:

$$d' = \ldots\ m$$

Cara 1

➢ *Posisi merupakan integral dari kurva kecepatan*



$$L_I = L_\triangle \qquad L_{II} = L_\triangle$$
$$= 1/2 \cdot alas \cdot tinggi \qquad = 1/2 \cdot alas \cdot tinggi$$
$$= 1/2 \cdot 5 \cdot 40 \qquad = 1/2 \cdot 4 \cdot 30$$
$$= 100 \qquad = 60$$

➢ *Jarak antara kedua kereta ketika berhenti total*

$$d' = d - (L_I + L_2)$$
$$= 200 - (100 + 60)$$
$$= 40\ m$$

□

Cara 2

➢ *Percepatan merupakan gradien dari kurva kecepatan*

$$a_1 = m_I = \frac{y_2 - y_1}{x_2 - x_1} \qquad a_2 = m_2 = \frac{y_2 - y_1}{x_2 - x_1}$$
$$= \frac{0 - v_s}{t_2 - t_1} \qquad = \frac{0 - v_2}{t_2 - t_1}$$
$$= \frac{0 - 40}{5 - 0} \qquad = \frac{0 - 30}{4 - 0}$$
$$= -8\ m/s \qquad = -7.5\ m/s$$

➢ *Jarak kedua kereta sampai berhenti*

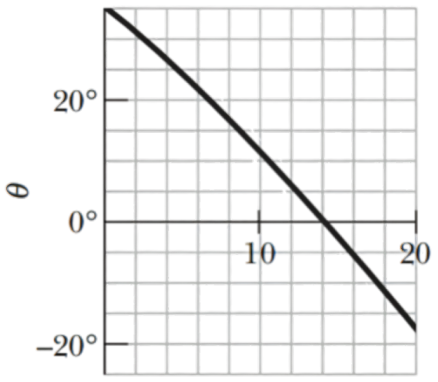
$$s_1 = v_0\ t\ +\ \frac{1}{2}\ at^2 \qquad s_2 = v_0\ t\ +\ \frac{1}{2}\ at^2$$
$$= v_s\ \cdot\ 5\ -\ \frac{1}{2} \cdot\ 8\ \cdot 5^2 \qquad = v_s\ \cdot\ 4\ -\ \frac{1}{2} \cdot\ \frac{15}{2}\ \cdot 4^2$$
$$= 100\ m \qquad = 60\ m$$

➢ *Jarak antara kedua kereta ketika berhenti total*

$$d' = d - (s_I + s_2)$$
$$= 200 - (100 + 60)$$
$$= 40\ m$$

□

2. The position vector $\vec{r} = 5t\,\hat{i} + \left(et + ft^2\right)\hat{j}$ locates a particle as a function of time t. Vector $\vec{r}$ is in meters, t is in seconds, and factors e and f are constants. The figure gives the angle θ of the particle's direction of travel as a function of t (θ is measured from the positive x direction). What are (a) e and (b) f, including units?



Materi: Vektor & Kinematika

➢ *Sudut antara arah gerak dengan sumbu-x*

$$\tan\theta = \frac{\overrightarrow{v_y}}{\overrightarrow{v_x}}$$

Diketahui:

$$\vec{r} = 5t\,\hat{i} + \left(et + ft^2\right)\hat{j}$$

Ditanya:

$$e = \ldots \qquad f = \ldots$$

Jawab.

➢ *Kecepatan merupakan turunan dari kurva posisi*

$$\overrightarrow{r_x} = 5t\,\hat{i} \qquad \overrightarrow{r_y} = \left(et + ft^2\right)\hat{j}$$
$$\frac{d\overrightarrow{r_x}}{dt} = 5\,\hat{i} \qquad \frac{d\overrightarrow{r_y}}{dt} = (e + 2ft)\,\hat{j}$$
$$\overrightarrow{v_x} = 5\,\hat{i} \qquad \overrightarrow{v_y} = (e + 2ft)\,\hat{j}$$

➢ *Dari grafik, $\theta = 35°$ saat $t = 0$*

$$\tan 35° = \frac{\overrightarrow{v_y}}{\overrightarrow{v_x}}$$
$$\tan 35° = \frac{e + 2t}{5}$$
$$\tan 35° = \frac{e + 2f(0)}{5}$$
$$e \approx 3.5\ m/s$$ □

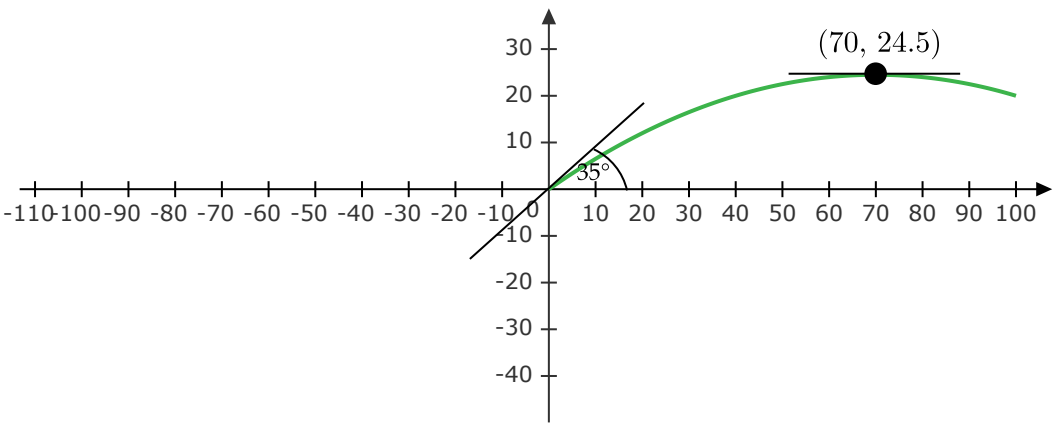
➢ *Dari grafik, $\theta = 0°$ (arah vektor sejajar dengan sumbu-x) saat $t = 14$*

$$\tan 0° = \frac{\overrightarrow{v_y}}{\overrightarrow{v_x}}$$
$$0 = \frac{\overrightarrow{v_y}}{\overrightarrow{v_x}}$$
$$\overrightarrow{v_y} = 0$$

➢ *Substitusi $\overrightarrow{v_y} = 0$ saat $t = 14$*

$$\overrightarrow{v_y} = (e + 2ft)\,\hat{j}$$
$$0 = e + 2ft$$
$$f = \frac{-e}{2t}$$
$$= \frac{-3.5}{2(14)}$$
$$\approx -0.125\ m/s$$ □

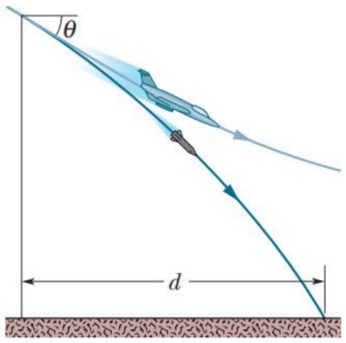
➢ *Grafik*



3. A certain airplane has a speed of $290\ km/h$ and is diving at an angle of $\theta = 30°$ below the horizontal when the pilot releases a radar decoy (see figure). The horizontal distance between the release point and the point where the decoy strikes the ground is $d = 700\ m$.

   a. How long is the decoy in the air?

   b. How high was the release point?



Materi: Kinematika

➢ *Gerak Parabola*

GLB

$$x - x_0 = v_{0x}\, t = v_0 \cos\theta\, t$$

GLBB

$$y - y_0 = v_{0y}\, t + \frac{1}{2} at^2 = v_0 \sin\theta\, t - \frac{1}{2} gt^2$$

Diketahui:

$x_0 = 0\ m$ $\quad \theta = 30°$ $\quad v_0 = 290\ km/h$

$x = 700\ m$ $\quad \theta' = -30°$ $\quad = 80.6\ m/s$

Ditanya:

$$t = \ldots\ s \quad \& \quad y_0 = \ldots$$

Jawab.

➢ *Mencari nilai* t

$$\begin{aligned} x - x_0 &= v_0 \cos\theta\, t \\ 700 - 0 &= 80.6 \cdot \cos(-30°) \cdot t \\ t &= \frac{700}{69.8} \\ &= 10\ s \end{aligned}$$

□

➢ *Mencari nilai* y_0

$$y - y_0 = v_0 \sin\theta\, t - \frac{1}{2} gt^2$$

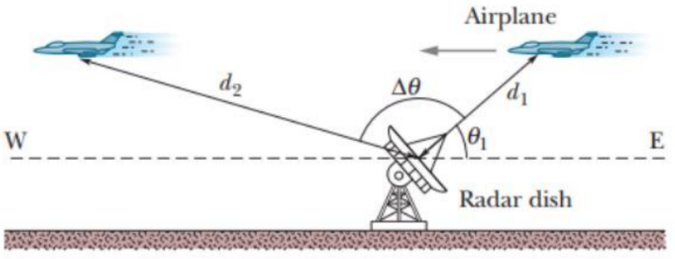
$$0 - y_0 = 80.6 \cdot \sin(-30°) \cdot 10 - \frac{1}{2} \cdot 9.8 \cdot 10^2$$

$$-y_0 = -893$$

$$y_0 = 893\ m$$

□

4. In the following figure, a radar station detects an airplane approaching directly from the east. At first observation, the airplane is at distance $d_1 = 360\ m$ from the station and at angle $\theta = 40°$ above the horizon. The airplane is tracked through an angular change $\Delta\theta = 123°$ in the vertical east–west plane; its distance is then $d_2 = 790\ m$. Find:
   a. Magnitude of the airplane's displacement during this period
   b. Direction of the airplane's displacement during this period in vector notations.



Materi: Kinematika

➢ *Aturan Cosinus*

$$a^2 = \sqrt{b^2 + c^2 - 2bc\cos A}$$

Diketahui:

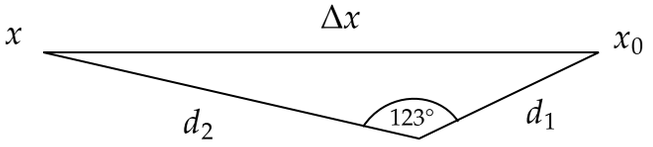
$$d_1 = 360\ m \qquad d_2 = 790\ m \qquad \Delta\theta = 123°$$

Ditanya:

$$\Delta x = \ldots\ m \quad \& \quad \hat{n} = \ldots$$

Jawab.

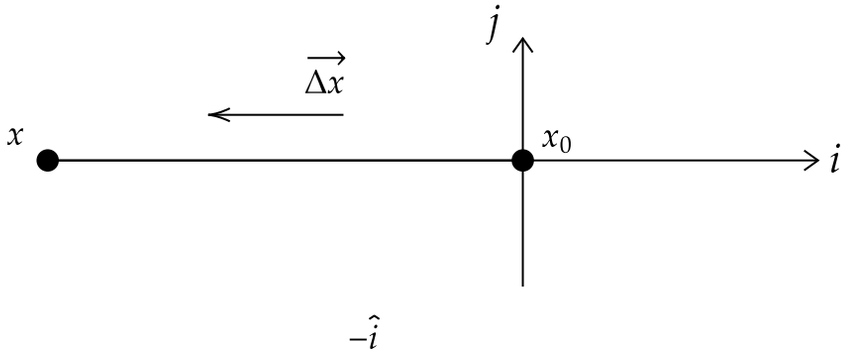
➢ *Mencari* Δx



$$\begin{aligned}\Delta x &= \sqrt{(d_1)^2 + (d_2)^2 - 2(d_1)(d_2)\cos\Delta x} \\ &= \sqrt{360^2 + 790^2 - 2(360)(790)\cos(123°)} \\ &\approx 1031.25\ m\end{aligned}$$

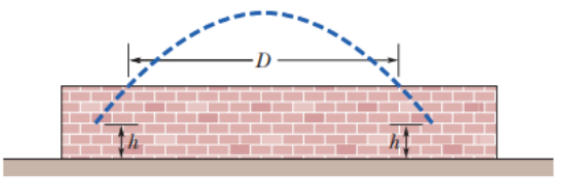
□

➢ *Arah perpindahan*



□

5. In the following figure, a baseball is hit at a height $h = 1\ m$ and then caught at the same height. It travels alongside a wall, moving up past the top of the wall $1\ s$ after it is hit then down past the top of the wall $4\ s$ later, at distance $D = 50\ m$ farther along the wall.
   a. What horizontal distance is traveled by the ball from hit to catch?
   b. What is the magnitude of the ball's velocity just after being hit?
   c. What is the angle (relative to the horizontal) of the ball's velocity just after being hit?
   d. How high is the wall?



Materi: Kinematika

➢ *Gerak Parabola*

$$\underset{GLB}{x - x_0 = v_{0x}\, t = v_0 \cos\theta\, t} \qquad \underset{GLBB}{y - y_0 = v_{0y}\, t + \frac{1}{2} a t^2 = v_0 \sin\theta\, t - \frac{1}{2} g t^2}$$

Diketahui:

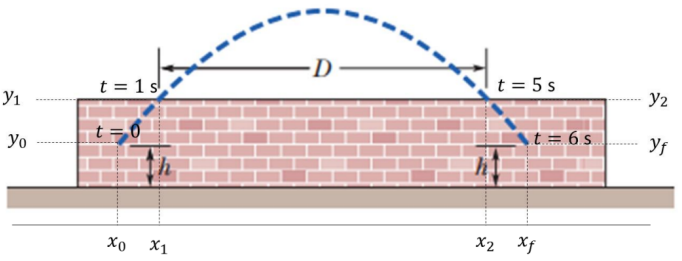
$$t_{0,A} = 1\ s \qquad t_{A,C} = 4\ s \qquad D = 50\ m \qquad h_0 = \ldots$$

Ditanya:

$$s_x = \ldots\ s \quad \& \quad v_0 = \ldots \quad \& \quad \theta = \ldots \quad \& \quad h_{dinding} = \ldots$$

Jawab.

➢ *Ilustrasi*



➢ *a)*

$$\begin{aligned} t_{total} &= t_{0,A} + t_{A,C} + t_{C,0} \\ &= 1 + 4 + 1 \\ &= 6\ s \end{aligned}$$

Maka

$$v_x = \frac{D}{t_{total}} = \frac{50}{4} = \frac{25}{2}\ m/s$$

Sehingga

$$s_x = v_x \cdot t_{total} = \frac{25}{2} \cdot 6 = 75\ m \qquad \square$$

➢ *b)*

$$\begin{aligned} t_{0,B} &= t_{0,A} + t_{A,B} \\ &= 1 + 2 \\ &= 3\ s \end{aligned}$$

Substitusi

$$\begin{aligned} v_y' &= v_0 + at \\ 0 &= v_0 - g\, t_{0,B} \\ v_{0_y} &= g\, t_{0 \to B} \\ &= 9.8 \cdot 3 \\ &= 29.4\ m/s \end{aligned}$$

Dalam vektor

$$\vec{v} = (12.5\,\hat{i} + 29.4\,\hat{j})\ m/s \qquad \square$$

➢ *c)*

$$\tan\theta = \frac{\overrightarrow{v_y}}{\overrightarrow{v_x}}$$

$$\begin{aligned} \theta &= \tan^{-1}\left(\frac{29.4}{12.5}\right) \\ &= 66.96^\circ \\ &\approx 67^\circ \end{aligned} \qquad \square$$

➢ *d)*

$$\begin{aligned} h_{dinding} &= h_0 + h_A \\ &= h_0 + (v_{y_0} \cdot t_{0 \to A} - \frac{1}{2} g (t_{0,A})^2 \\ &= 1 + (29.4 \cdot 1 - \frac{1}{2} \cdot 9.8 \cdot 1^2 \\ &= 25.5\ m \end{aligned} \qquad \square$$

6. The fast French train known as the TGV (Train à Grande Vitesse) has a scheduled average speed of $216\,km/h$. (a) If the train goes around a curve at that speed and the magnitude of the acceleration experienced by the passengers is to be limited to $0.050g$, what is the smallest radius of curvature for the track that can be tolerated? (b) At what speed must the train go around a curve with a $1.00\,km$ radius to be at the acceleration limit?

Materi: Kinematika

➢ *Gerak Melingkar*

$$a_s = \frac{v^2}{r}$$

Diketahui:

$$v_{train} = 216\,km/h = 60\,m/s$$

Ditanya:

$$r = \ldots\ m \quad \& \quad v_{r=1\,km} = \ldots$$

Jawab.

➢ *a) Pada kecepatan konstan*

$$\vec{a} = \overrightarrow{a_s}$$

Karena $r > 0$ *maka*

$$\begin{aligned}
\vec{a} &\leqslant 0.05g \\
\overrightarrow{a_s} &\leqslant 0.05g \\
\frac{v^2}{r} &\leqslant 0.05g \\
r &\leqslant \frac{60^2}{0.05 \cdot 9.8} \\
&\leqslant 7346,9 \\
&\approx 735\,m \\
&\approx 7,35 \times 10^3\,m \\
&\approx 7,35\,km
\end{aligned}$$

□

➢ *b) Pada kecepatan konstan*

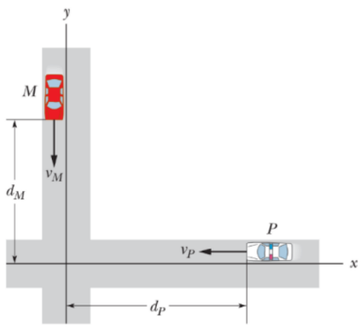
$$\vec{a} = \overrightarrow{a_s}$$

Karena $r > 0$ *maka*

$$\begin{aligned}
\vec{a} &\leqslant 0.05g \\
\overrightarrow{a_s} &\leqslant 0.05g \\
\frac{v^2}{r} &\leqslant 0.05g \\
v^2 &\leqslant 0.05 \cdot g \cdot r \\
v &\leqslant \sqrt{0.05 \cdot 9.8 \cdot 1} \\
&\approx 22.14\,m/s
\end{aligned}$$

□

7. Two highways intersect as shown in the figure. At the instant shown, a police car P is at a distance $d_p = 800\,m$ from the intersection and moving at speed $v_p = 80\,km/h$. Motorist M is at a distance $d_M = 600\,m$ from the intersection and moving at speed $v_M = 60\,km/h$. (a) In unit-vector notation, what is the velocity of the motorist with respect to the police car? (b) For the instant shown in the figure, what is the angle between the velocity found in (a) and the line of sight between the two cars? (c) If the cars maintain their velocities, do the answers to (a) and (b) change as the cars move nearer the intersection?



Materi: Kinematika

➢ *Kecepatan Relatif*

$$\overrightarrow{v_{a,b}} = \vec{v}_a - \vec{v}_b$$

Diketahui:

$$v_p = 80\,km/h \quad v_m = 60\,km/h$$

Ditanya:

$$\overrightarrow{v_{m,p}} = \ldots\ m/s \quad \& \quad \theta_{m,p}$$

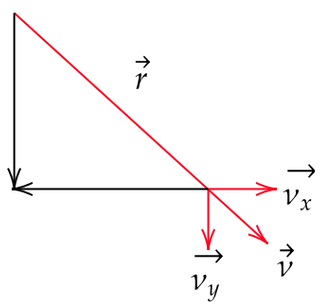
Jawab.

➢ *a)*

$$\begin{aligned}\overrightarrow{v_{m,p}} &= \vec{v}_m - \vec{v}_p \\ &= (-60\,\hat{j}) - (-80\,\hat{i}) \\ &= (80\,\hat{i} - 60\,\hat{j})\end{aligned}$$

➢ *b)*

$$\vec{r} = 800\,\hat{i} - 600\hat{j}$$



Sehingga

$$\theta = 0° \qquad \square$$

➢ *c)*

No $\qquad \square$

8. A 0.34 kg particle moves in an xy plane according to $x(t) = -15 + 2t - 4t^3$ and $y(t) = 25 + 7t - 9t^2$, with x and y in meters and t in seconds. At $t = 0.7\,s$, what are
   (a) the magnitude,
   (b) the angle (relative to the positive direction of the x axis) of the net force on the particle, and
   (c) what is the angle of the particle's direction of travel.

Materi: Vektor & Kinematika

➢ *Gaya*

$$F = ma$$

Diketahui:

$$m = 0.34\,kg \qquad t = 0.7\,s$$

Ditanya:

$$F = \ldots\ N \quad \& \quad \theta_{p,x} = \ldots^\circ$$

Jawab.

➢ *a) Percepatan merupakan turunan kedua dari posisi*

$$\begin{aligned}\vec{a_x}(t) &= \frac{d\vec{v_x}}{dt} = \frac{d^2\vec{x}}{dt}\\ &= \frac{d^2}{dt}\left(-15 + 2t - 4t^3\right)\\ &= -24t\\ \vec{a_x}(0.7) &= -24(0.7)\\ &= -16.8\ m/s\end{aligned} \qquad \begin{aligned}\vec{a_y}(t) &= \frac{d\vec{v_y}}{dt} = \frac{d^2\vec{y}}{dt}\\ &= \frac{d^2}{dt}\left(25 + 7t - 9t^2\right)\\ &= -18\ m/s\end{aligned}$$

Komponen percepatan saat $t = 0.7$

$$\vec{a} = -16.8\,\hat{i} - 18\,\hat{j}$$

Besar percepatan

$$\begin{aligned}|\vec{a}| &= \sqrt{\left(\vec{a_x}\right)^2 + \left(\vec{a_y}\right)^2}\\ &= \sqrt{(-16.8)^2 + (-18)^2}\\ &\approx 24.62\ m/s^2\end{aligned}$$

Sehingga

$$F = m \cdot a = 0.34 \cdot 24.62 \approx 8.37\ N$$ □

➢ *b)*

Komponen vektor F

$$\begin{aligned}\vec{a} &= -16.8\,\hat{i} - 18\,\hat{j}\\ \vec{F} = m\vec{a} &= (-16.8)\cdot(0.34)\,\hat{i} - (18)(0.34)\,\hat{j}\\ &= -5.712\,\hat{i} - 6.12\,\hat{j}\end{aligned}$$

Besar sudut

$-\hat{i}$ *dan* $-\hat{j}$ *maka berada di kuadran III*

$$\tan\theta = \frac{a_y}{a_x}$$

$$\theta = \tan^{-1}\left(\frac{18}{16.8}\right)$$

$$\approx 46^\circ$$

Kuadran III $(180^\circ + \theta)$

$$180^\circ + \theta = 180^\circ + 46^\circ = 226^\circ$$ □

➢ *c) Kecepatan merupakan turunan pertama dari posisi*

$$\begin{aligned}\vec{v_x}(t) &= \frac{d\vec{x}}{dt}\\ &= \frac{d}{dt}\left(-15 + 2t - 4t^3\right)\\ &= 2 - 12t^2\\ \vec{v_x}(0.7) &= 2 - 12(0.7)^2\\ &= -3.88\ m/s\end{aligned} \qquad \begin{aligned}\vec{v_y}(t) &= \frac{d\vec{y}}{dt}\\ &= \frac{d}{dt}\left(25 + 7t - 9t^2\right)\\ &= 7 - 18t\ m/s\\ \vec{v_y}(0.7) &= 7 - 18(0.7)\\ &= -5.6\ m/s\end{aligned}$$

Komponen kecepatan

$$\vec{v} = -3.88\,\hat{i} - 5.6\,\hat{j}$$

Besar sudut

$-\hat{i}$ *dan* $-\hat{j}$ *maka berada di kuadran III*

$$\tan\theta = \frac{v_y}{v_x}$$

$$\theta = \tan^{-1}\left(\frac{5.6}{3.88}\right)$$

$$\approx 55^\circ$$

kuadran III $(180^\circ + \theta)$

$$180^\circ + \theta = 180^\circ + 55^\circ = 235^\circ$$ □

9. A banked circular highway curve is designed for traffic moving at $60\,km/h$. The radius of the curve is $200\,m$. Traffic is moving along the highway at $40\,km/h$ on a rainy day. What is the minimum coefficient of friction between tires and road that will allow cars to take the turn without sliding off the road? (Assume the cars do not have negative lift.)

Materi: Dinamika

➢ *Gerak Melingkar*

$$\overrightarrow{v_{a,b}} = \overrightarrow{v_a} - \overrightarrow{v_b}$$

Diketahui:

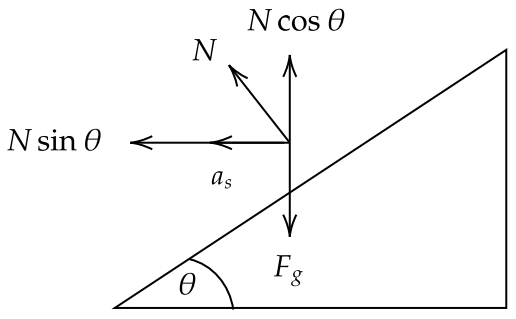
$$v_{normal} = 60\,km/h \approx 17\,m/s \qquad v_{rain} = 40\,km/h = \frac{100}{9}\,m/s \qquad r = 200\,m$$

Ditanya:

$$\mu_s = \ldots$$

Jawab.

➢ *Diagram Benda Bebas (dari tampak belakang mobil, hujan)*



$$\begin{aligned} &sumbu - x \\ \Sigma F_x &= 0 \\ N\cos\theta - F_g &= 0 \\ N\cos\theta &= mg \quad \ldots (1) \end{aligned} \qquad \begin{aligned} &sumbu - y \\ \Sigma F_y &= ma \\ N\sin\theta &= ma \\ N\sin\theta &= \frac{mv^2}{r} \quad \ldots (2) \end{aligned}$$

➢ *Substitusi*

$$\frac{N\sin\theta}{N\cos\theta} = \frac{mv^2}{mgr} \quad \ldots (3)$$

$$\tan\theta = \frac{v^2}{gr}$$

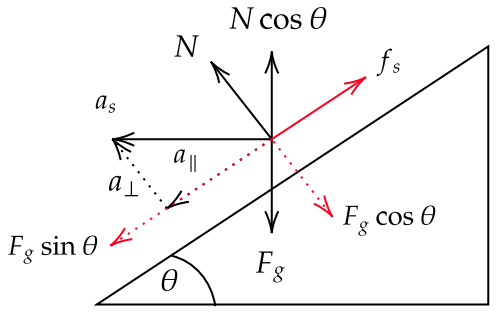
$$= \frac{(17)^2}{9.8 \cdot 200} \approx 8.4^\circ$$

➢ *Komponen Percepatan*

$$a_{\parallel} = a' \cos\theta = \frac{v^2}{r}\cos\theta$$

$$a_{\perp} = a' \sin\theta = \frac{v^2}{r}\sin\theta$$

➢ *Diagram Gaya Bebas II*



$$\begin{aligned} &sumbu - x \\ \Sigma F_x &= ma_{\parallel} \\ F_g\sin\theta - f_s &= ma_{\parallel} \\ f_s &= F_g\sin\theta - ma_{\parallel} \quad \ldots (1) \end{aligned} \qquad \begin{aligned} &sumbu - y \\ \Sigma F_x &= ma_{\perp} \\ N - F_g\cos\theta &= ma_{\perp} \\ N &= F_g\cos\theta + ma_{\perp} \quad \ldots (2) \end{aligned}$$

➢ *Substitusi*

$$f_s = \mu_s N$$

$$\mu_s = \frac{f_s}{N}$$

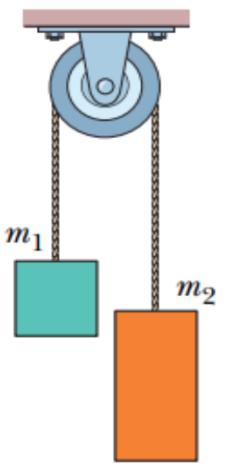
$$= \frac{\cancel{m}g\sin\theta - \cancel{m}\left(\frac{v^2}{r}\cos\theta\right)}{\cancel{m}g\cos\theta + \cancel{m}\left(\frac{v^2}{r}\sin\theta\right)}$$

$$= \frac{(9.8)\sin(8.4^\circ) - \frac{(11)^2}{200}\cos(8.4^\circ)}{(9.8)\cos(8.4^\circ) + \frac{(11)^2}{200}\sin(8.4^\circ)}$$

$$= 0.089$$

□

10. The next figure shows Atwood's machine, in which two containers are connected by a cord (of negligible mass) passing over a frictionless pulley (also of negligible mass). At time $t = 0$, container 1 has mass $1.30\,kg$ and container 2 has mass $2.80\,kg$, but container 1 is losing mass (through a leak) at the constant rate of $0.200\,kg/s$. At what rate is the acceleration magnitude of the containers changing at (a) $t = 0$ and (b) $t = 3.00\,s$? (c) When does the acceleration reach its maximum value?



Materi: Kinematika & Dinamika

➢ *Chain Rule*

$$\frac{dy}{dt} = \frac{dy}{dx} \cdot \frac{dx}{d\theta} \cdot \frac{d\theta}{dt}$$

Diketahui:

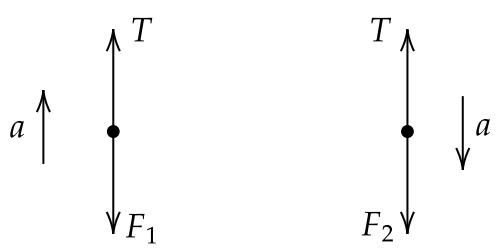
$$m_1 = 1.3\,kg \qquad m_2 = 2.8\,kg \qquad \frac{dm}{dt} = 0.2\,kg/s$$

Ditanya:

$$a_{t=0\,s} = \ldots \quad \& \quad a_{t=3\,s} \quad \& \quad t_{a=max} = \ldots$$

Jawab.

➢ *Diagram Benda Bebas*



benda I

$$\Sigma F = ma$$
$$T - m_1 g = m_1 a$$
$$T = m_1 a + m_1 g$$

benda II

$$\Sigma F = ma$$
$$m_2 g - T = ma$$
$$T = m_2 g - m_2 a$$

➢ *Substitusi*

$$T = T$$
$$m_1 a + m_1 g = m_2 g - m_2 a$$
$$m_2 a + m_1 a = m_2 g - m_1 g$$
$$a(m_2 + m_1) = (m_2 - m_1)g$$
$$a = \frac{m_2 - m_1}{m_1 + m_2} g \qquad m/s^2$$

➢ *a)*

$$\frac{da}{dt} = \frac{da}{dm_1} \cdot \frac{dm_1}{dt}$$
$$= \frac{d}{dm_1}\left(\frac{m_2 - m_1}{m_2 + m_1} g\right) \cdot (-0.2)$$
$$= \frac{2m_2 g}{(m_2 + m_1)^2} \cdot (-0.2)$$
$$= \frac{2 \cdot 2.8 \cdot 9.8}{(2.8 + 1.3)^2} \cdot (-0.2)$$
$$= 0.653\,m/s^3$$ □

➢ *b)*

$$m_1{}' = m_0 + \left(\frac{dm}{dt}\right)t$$
$$= 1.3 + (-0.2)(3)$$
$$= 0.7\,kg$$

Sehingga

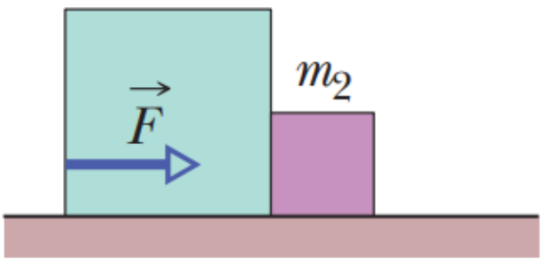
$$\frac{da}{dt} = \frac{da}{dm_1{}'} \cdot \frac{dm_1{}'}{dt}$$
$$= \frac{d}{dm_1}\left(\frac{m_2 - m_1{}'}{m_2 + m_1{}'} g\right) \cdot (-0.2)$$
$$= \frac{2m_2 g}{(m_2 + m_1{}')^2} \cdot (-0.2)$$
$$= \frac{2 \cdot 2.8 \cdot 9.8}{(2.8 + 0.7)^2} \cdot (-0.2)$$
$$= 0.896\,m/s^3$$ □

➢ *c)*

nilai maksimum terjadi saat $m_1{}' = 0$

$$m_1{}' = 0$$
$$m_0 + \left(\frac{dm}{dt}\right)t = 0$$
$$1.3 + (-0.2)t = 0$$
$$0.2t = 1.3$$
$$t = 6.5\,s$$ □

11. Two blocks are in contact on a frictionless table. A horizontal force is applied to the larger block, as shown in the figure. (a) If $m_1 = 2.3\,kg$, $m_2 = 1.2\,kg$, and $F = 3.2\,N$, find the magnitude of the force between the two blocks. (b) If a force of the same magnitude F is applied to the smaller block but in the opposite direction, find the magnitude of the force between the blocks, (c) compare the two magnitudes in (a) and (b), explain the difference.



Materi: Dinamika

➢ *Hukum Newton I dan II*

$$\Sigma F = 0 \quad \& \quad \Sigma F = ma$$

Diketahui:

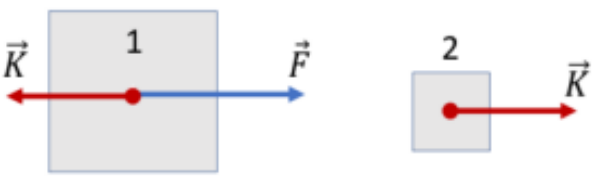
$$m_1 = 2.3\,kg \qquad m_2 = 1.2\,kg \qquad F = 3.2\,N$$

Ditanya:

$$N = \ldots \quad \& \quad N' = \ldots$$

Jawab.

➢ *a) Diagram Benda Bebas*



sistem

$$\Sigma F = \Sigma m \cdot a$$
$$F = (m_1 + m_2)\, a$$
$$a = \frac{F}{m_1 + m_2}$$

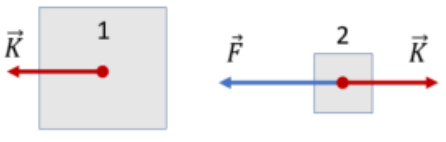
benda I

$$\Sigma F = ma$$
$$F - N = m_1\, a$$

➢ *Substitusi*

$$F - N = m_1 \cdot \frac{F}{m_1 + m_2}$$
$$N = F - \frac{m_1 \cdot F}{m_1 + m_2}$$
$$N = \frac{m_2}{m_1 + m_2} F$$
$$= \frac{1.2}{2.3 + 1.2} \cdot 3.2$$
$$\approx 1.09\,N$$ □

➢ *b) Diagram Benda Bebas*



sistem

$$\Sigma F = \Sigma m \cdot a$$
$$F - F = (m_1 + m_2)\, a$$
$$= \frac{F}{m_1 + m_2}$$

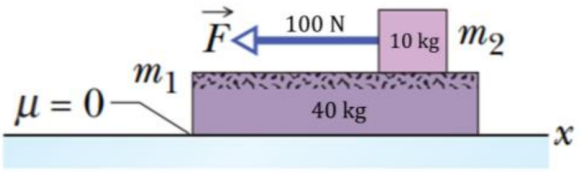
benda II

$$\Sigma F = ma$$
$$F - N = m_2\, a$$

➢ *Substitusi*

$$F - N = m_2 \cdot \frac{F}{m_1 + m_2}$$
$$N = F - \frac{m_2 \cdot F}{m_1 + m_2}$$
$$N = \frac{m_1}{m_1 + m_2} F$$
$$= \frac{2.3}{2.3 + 1.2} \cdot 3.2$$
$$\approx 2.1\,N$$ □

12. In the next figure, a slab of mass $m_1 = 40\,kg$ rests on a frictionless floor, and a block of mass $m_2 = 10\,kg$ rests on top of the slab. Between block and slab, the coefficient of static friction is 0.60, and the coefficient of kinetic friction is 0.40. A horizontal force of magnitude $100\,N$ begins to pull directly on the block, as shown. In unit-vector notation, what are the resulting accelerations of (a) the block and (b) the slab?



Materi: Dinamika

➢ *Hukum Newton I dan II*

$$\Sigma F = 0 \quad \& \quad \Sigma F = ma$$

Diketahui:

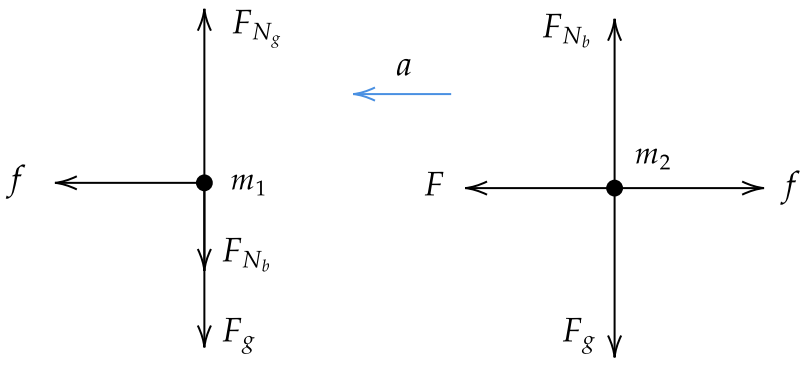
$$m_1 = 40\,kg \quad m_2 = 10\,kg \quad \mu_s = 0.6 \quad \mu_k = 0,4 \quad \vec{F} = 100\,N$$

Ditanya:

$$a_{block} = \ldots \quad \& \quad a_{slab} = \ldots$$

Jawab.

➢ *a) Diagram Benda Bebas*



➢ *Tinjau m_2*

$$\begin{aligned} &sumbu - y \\ \Sigma F_y &= 0 \\ W_2 - N_{2,1} &= 0 \\ m_2\,g - N_{2,1} &= 0 \\ N_{2,1} &= m_2\,g \end{aligned}$$

$$\begin{aligned} &sumbu - x \\ \Sigma F_x &= m_1\,a_1 \\ F - f_g &= m_1\,a_1 \\ F - \mu\,N_{2,1} &= m_1\,a_1 \\ a_1 &= \frac{F - \mu\,(m_2\,g)}{m_2} \end{aligned}$$

Keadaan benda 2

$$\begin{aligned} f_s &= \mu_s\,N_{2,1} \\ &= \mu_s\,(m_2\,g) \\ &= 0.6 \cdot 10 \cdot 9.8 \\ &= 58.8\,N \end{aligned} \qquad \begin{aligned} 58.8\,N &< 100\,N \\ f_s &< F \end{aligned}$$

benda 2 bergerak (menggunakan μ_k)

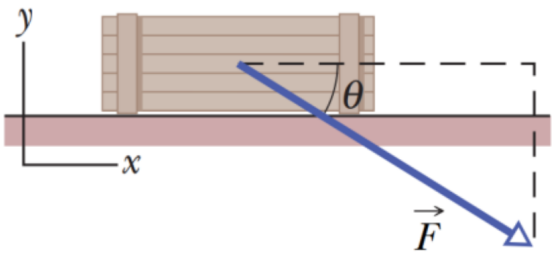
➢ *Tinjau m_2*

$$\begin{aligned} &sumbu - x \\ \Sigma F_x &= m_2\,a_2 \\ f_k - F &= m_2\,a_2 \\ \mu_k\,N_{1,2} - F &= m_2\,a_2 \\ \mu_k\,(m_2\,g) - F &= m_2\,a_2 \\ a_2 &= \frac{\mu_k\,m_2\,g - F}{m_2} \\ &= \frac{0.4 \cdot 10 \cdot 9.8 - 100}{10} \\ &\approx -6.08\,m/s^2 \end{aligned}$$ □

➢ *Analisis Percepatan*

$$\begin{aligned} &sumbu - x \\ \Sigma F_x &= m_1\,a_1 \\ f_k &= m_1\,a_1 \\ \mu_k\,N_{1,2} &= m_1\,a_1 \\ \mu_k\,(m_2\,g) &= m_1\,a_1 \\ a_1 &= \frac{\mu_k\,(m_2\,g)}{m_1} \\ &\approx -0.98\,m/s^2 \end{aligned}$$ □

13. In the figure, force $\vec{F}$ is applied to a crate of mass m on a floor where the coefficient of static friction between crate and floor is μ_S. Angle θ is initially $0°$ but is gradually increased so that the force vector rotates clockwise in the figure. During the rotation, the magnitude F of the force is continuously adjusted so that the crate is always on the verge of sliding. For $\mu_s = 0.70$, (a) plot the ratio F/mg versus θ and (b) determine the angle θ_{inf} at which the ratio approaches an infinite value. (c) Does lubricating the floor increase or decrease θ_{inf}, or is the value unchanged? (d) What is θ_{inf} for $\mu_s = 0.60$?



Materi: Dinamika

➢ *Hukum Newton I dan II*

$$\Sigma F = 0 \quad \& \quad \Sigma F = ma$$

Diketahui:

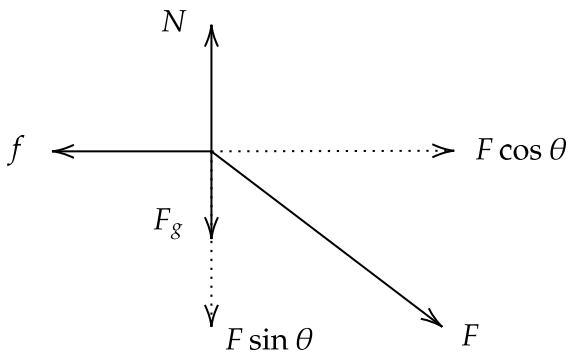
$$m_1 = 40\ kg \quad m_2 = 10\ kg \quad \mu_s = 0.6 \quad \mu_k = 0,4 \quad \vec{F} = 100\ N$$

Ditanya:

$$a_{block} = \ldots \quad \& \quad a_{slab} = \ldots$$

Jawab.

➢ *a) Diagram Benda Bebas*



$$\begin{aligned} &sumbu - x \\ \Sigma F_x &= 0 \\ F\cos\theta - f_g &= 0 \\ F\cos\theta - \mu_s N &= 0 \\ F\cos\theta &= \mu_s(mg + F\sin\theta) \\ F\cos\theta - F\sin\theta\,\mu_s &= \mu_s\, mg \\ F(\cos\theta - \mu_s \sin\theta) &= \mu_s\, mg \\ \frac{F}{mg} &= \frac{\mu_S}{\cos\theta - \sin\theta} \end{aligned}$$

$$\begin{aligned} &sumbu - y \\ \Sigma F_y &= 0 \\ N - mg - F\sin\theta &= 0 \\ N &= mg + F\sin\theta \end{aligned}$$

□

➢ *b)*

$$\frac{F}{mg} \approx \infty$$

$$\frac{\mu_S}{\cos\theta - \mu_s \sin\theta} \approx \infty$$

terjadi saat

$$\begin{aligned} \cos\theta - \mu_s \sin\theta &\approx 0 \\ \cos\theta &\approx \mu_s \sin\theta \\ \frac{\sin\theta}{\cos\theta} &\approx \frac{1}{\mu_s} \\ \tan\theta &\approx \frac{1}{\mu_s} \\ \theta &\approx \tan^{-1}\left(\frac{1}{\mu_s}\right) \\ &\approx \tan^{-1}\left(\frac{1}{0.7}\right) \\ &\approx 55° \end{aligned}$$

□

➢ *c)*

$$\theta \approx \tan^{-1}\left(\frac{1}{\mu_s}\right)$$

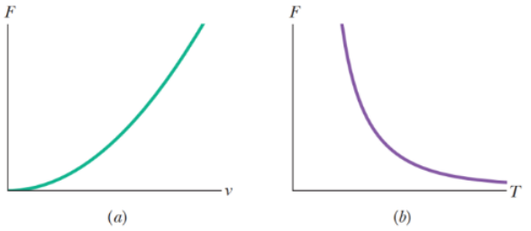
ketika μ_s mengecil maka θ membesar (berbalik nilai) □

➢ *d)*

$$\begin{aligned} \theta &\approx \tan^{-1}\left(\frac{1}{\mu_s}\right) \\ &\approx \tan^{-1}\left(\frac{1}{0.6}\right) \\ &\approx \tan^{-1}\left(\frac{10}{6}\right) \\ &\approx 59.03° \end{aligned}$$

□

14. An 85.0 kg passenger is made to move along a circular path of radius $r = 3.50\ m$ in uniform circular motion. (a) Figure a is a plot of the required magnitude F of the net centripetal force for a range of possible values of the passenger's speed v. What is the plot's slope at $v = 8.30\ m/s$? (b) Figure b is a plot of F for a range of possible values of T, the period of the motion. What is the plot's slope at $T = 2.50\ s$?



Materi: Dinamika

➢ *Gerak Melingkar*

$$F_s = ma_s = m\frac{v^2}{r} = m\,\omega^2 r \qquad \omega = \frac{2\pi}{T}$$

Diketahui:

$$m = 85\ kg \qquad r = 3.5\ kg \qquad v = 8.3\ m/s \qquad T' = 2.5\ s$$

Ditanya:

$$\frac{dF}{dv} = \ldots\ ? \qquad \frac{dF}{dT} = \ldots\ ?$$

Jawab.

➢ *a)*

$$\begin{aligned} d(F) &= d\left(\frac{mv^2}{r}\right) dv \\ dF &= \frac{m}{r}\, d\left(v^2\right) dv \\ \frac{dF}{dv} &= \frac{m}{r} \cdot 2v \\ &= \frac{85}{3.5} \cdot 2 \cdot 8.3 \\ &\approx 403.14\ Ns/m \end{aligned}$$ □

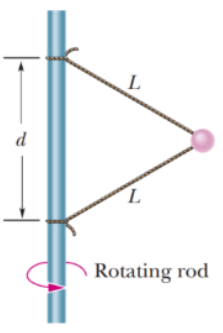
➢ *b)*

$$\begin{aligned} F &= m\omega^2 r \\ &= m\left(\frac{2\pi}{T}\right)^2 r \\ &= \frac{4\pi^2 mr}{T^2} \end{aligned}$$

Sehingga

$$\begin{aligned} d(F) &= d\left(\frac{4\pi^2 mr}{T^2}\right) dT \\ dF &= 4\pi^2 mr\ d\left(T^{-2}\right) dT \\ dF &= 4\pi^2 mr \cdot \left(-2T^{-3}\right) dT \\ \frac{dF}{dT} &= \frac{-8\pi^2 mr}{T^3} \\ &= \frac{-8\pi^2 \cdot 85 \cdot 3.5}{(2.5)^3} \\ &\approx -1503.34\ N/s \\ &\approx -1.5 \times 10^3\ N/s \end{aligned}$$ □

15. A $1.34\,kg$ ball is connected by means of two massless strings, each of length $L = 1.70\,m$, to a vertical, rotating rod. The strings are tied to the rod with separation $d = 1.70\,m$ and are taut. The tension in the upper string is $35\,N$. What are the (a) tension in the lower string, (b) magnitude of the net force $\overrightarrow{F_{net}}$ on the ball, and (c) speed of the ball? (d) What is the direction of $\overrightarrow{F_{net}}$?



Materi: Dinamika

➢ *Hukum Newton I dan II*

$$\Sigma F = 0 \qquad \& \qquad \Sigma F = ma$$

Diketahui:

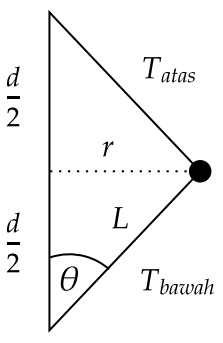
$$m_1 = 40\,kg \qquad m_2 = 10\,kg \qquad \mu_s = 0.6 \qquad \mu_k = 0,4 \qquad \vec{F} = 100\,N$$

Ditanya:

$$a_{block} = \ldots \quad \& \quad a_{slab} = \ldots$$

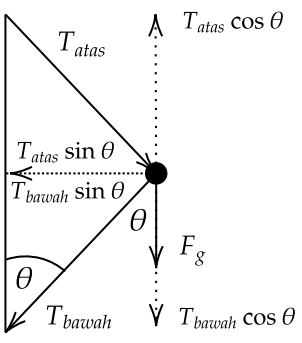
Jawab.

➢ *Trigonometri*



$$r = \sqrt{L^2 - \frac{d^2}{4}} \qquad \cos\theta = \frac{d}{2L} \qquad \sin\theta = \frac{\sqrt{L^2 - \frac{d^2}{4}}}{L}$$

➢ *a) Diagram Benda Bebas*



$$\text{sumbu} - y$$

$$\begin{aligned}
\Sigma F_y &= 0 \\
T_2\cos\theta - T_1\cos\theta - mg &= 0 \\
T_1\cos\theta &= T_2\cos\theta + mg \\
T_1 &= \frac{T_2\cos\theta + mg}{\cos\theta} \\
&= \frac{T_2\left(\frac{d}{2L}\right) + mg}{\left(\frac{d}{2L}\right)} \\
&= \frac{T_2\,d \;+\; 2mgL}{d} \\
&= \frac{35\cdot 1.7 - 2\cdot 1.34\cdot 9.8\cdot 1.7}{1.7} \\
&= 8.74\,N
\end{aligned}$$

□

➢ *b)*

$$\text{sumbu} - x$$

$$\begin{aligned}
\Sigma F_x &= F_{net} \\
T_1\sin\theta + T_2\sin\theta &= F_{net} \\
F_{net} &= (T_1 + T_2)\sin\theta \\
&= (T_1 + T_2)\,\frac{\sqrt{L^2 - \frac{d^2}{4}}}{L} \\
&= (8.736 + 35)\,\frac{\sqrt{(1.7)^2 - \frac{(1.7)^2}{4}}}{(1.7)} \\
&\approx 37.87\,N
\end{aligned}$$

□

➢ *c)*

$$\text{kecepatan linier}$$

$$\begin{aligned}
F_{net} &= (T_1 + T_2)\sin\theta \\
m\cdot a_s &= (T_1 + T_2)\,\frac{\sqrt{L^2 - \frac{d^2}{4}}}{L} \\
m\cdot\frac{v^2}{r} &= (T_1 + T_2)\,\frac{\sqrt{L^2 - \frac{d^2}{4}}}{L} \\
m\cdot\frac{v^2}{\sqrt{L^2 - \frac{d^2}{4}}} &= (T_1 + T_2)\frac{\sqrt{L^2 - \frac{d^2}{4}}}{L} \\
v^2 &= \frac{(T_1 + T_2)\cdot\left(\sqrt{L^2 - \frac{d^2}{4}}\right)^2}{m\cdot L} \\
&= \frac{(8.736 + 35)\cdot\left((1.7)^2 - \frac{(1.7)^2}{4}\right)}{1.34\cdot(1.7)} \\
v^2 &\approx 41.61 \\
v &\approx 6.45\;\; m/s
\end{aligned}$$

□

$$\text{kecepatan sudut}$$

$$\begin{aligned}
\omega &= v\cdot r \\
&= v\cdot\sqrt{L^2 - \frac{d^2}{4}} \\
&= 6.45\cdot\sqrt{(1.7)^2 - \frac{(1.7)^2}{4}} \\
&\approx 9.49\;\; rad/s
\end{aligned}$$

□

➢ *d)*

dari diagram benda bebas terlihat bahwa arah dari F_{net} *ke kiri*

□