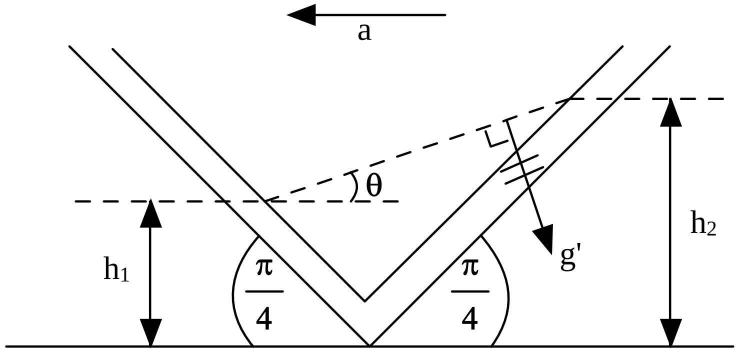
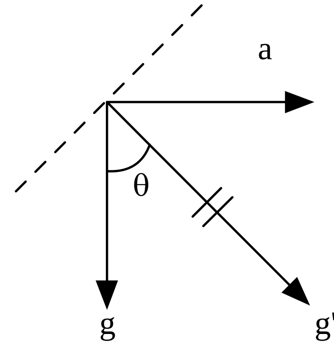
1. (7 Point)





(2 Point)

$$\tan\theta = \frac{h_2 - h_1}{h_1 + h_2}$$

$$\frac{a}{g} = \frac{h_2 - h_1}{h_2 + h_1}$$

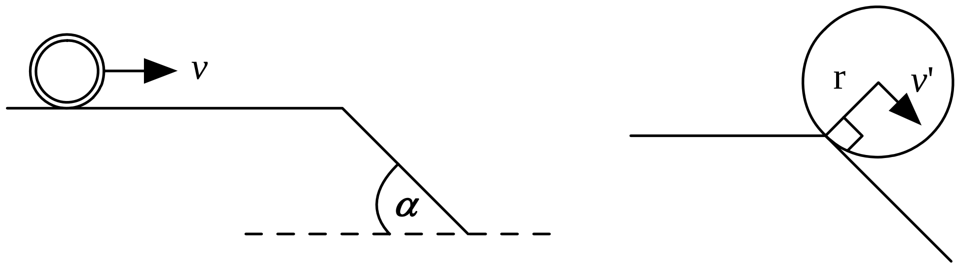
$$a = \frac{h_2 - h_1}{h_2 + h_1}.g$$

(5 Point)

Penjelasan :

Dalam medan gravitasi, cairan akan mencari posisi dengan energi minimum. Untuk medan gravitasi uniform, posisi ini tercapai saat permukaan air tegak lurus arah gravitasi. Dalam kasus ini percepatan $\vec{a}$ mengakibatkan gaya fiktif $m\vec{a}' = -m\vec{a}$ yang menghasilkan medan “gravitasi” $\vec{g}'$.

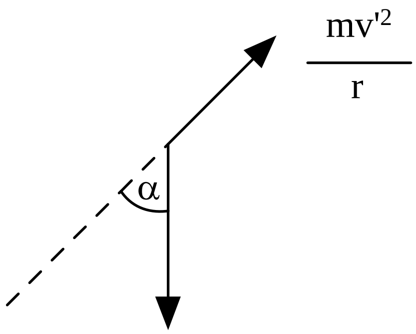
2. (10 Point)



$$\frac{1}{2}mv^2 + mgr = \frac{1}{2}mv'^2 + mgr\cos\alpha$$

$$v'^2 = v^2 + 2gr(1-\cos\alpha)$$ (3 Point)

Gaya pada (b) :



$$\frac{mv'^2}{r} = mg\cos\alpha$$ (4 Point)

$$v^2 + 2gr(1-\cos\alpha) = g.r\cos\alpha$$

$$v^2 = g\,r\,(3\cos\alpha - 2)$$

$$v = \sqrt{g\,r\,(3\cos\alpha - 2)}$$ (2 Point)

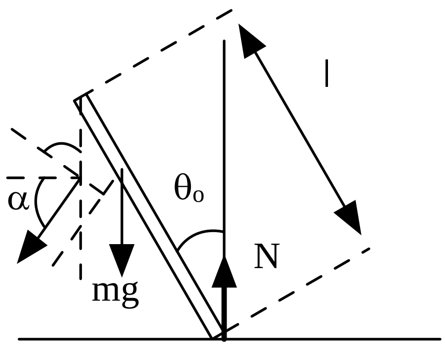
dengan syarat

$$3\cos\alpha - 2 \geq 0$$

$$\cos\alpha \geq \frac{2}{3}$$

$$\alpha \leq \cos^{-1}\left(\frac{2}{3}\right)$$ (1 Point)

3. (8 Point)



$$mg - N = ma \;\ldots\ldots\ldots\ldots\ldots(1)$$ (2 Point)

$$N\left(\frac{1}{2}l\right)\sin\theta_0 = I.\alpha \;\ldots\ldots\ldots(2)$$ (2 Point)

Karena

$$a = \alpha\left(\frac{1}{2}l\right)\sin\theta_0$$ (2 Point)

maka dari persamaan (1) dan (2)

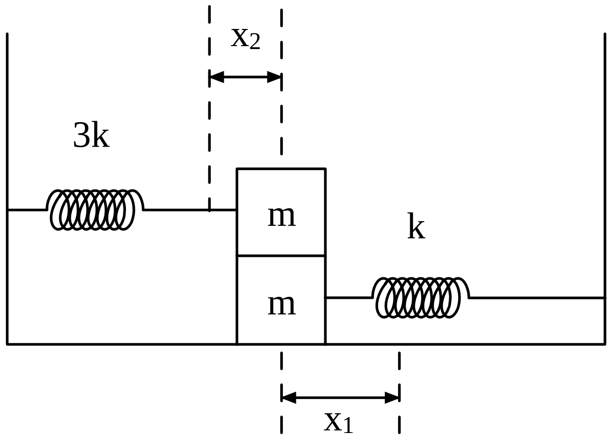
$$g - \frac{N}{m} = \frac{N\,l\sin\theta_0}{2I}.\frac{l}{2}\sin\theta_0$$

$$g - \frac{N}{m} = \frac{N\,l^2\sin^2\theta_0}{4.\frac{1}{12}ml^2}$$

$$mg - N = 3N\sin^2\theta_0$$

$$N = \frac{mg}{1+3\sin^2\theta_0}$$ (2 Point)

4. (15 Point)



Keadaan awal (keseimbangan) :

$x_1 = 3x_2$ (2Point)

Kedua balok akan lebih mudah terlepas, bisa disimpangkan ke kanan! (1 Point)

Anggap ada penyimpangan x_0 :

- Balok bawah :

  $k\left(x_1 - x_0\right) - f = ma_1$ (2 Point)

- Balok atas

  $-3k\left(x_2 + x_0\right) + f = ma_2$ (2 Point)

Mereka bergerak bersama jika $a_1 = a_2$, atau (1 Point)

$$k\left(x_1 - x_0\right) - f = -3k\left(x_2 + x_0\right) + f$$

$$kx_1 - kx_0 = -kx_1 - 3kx_0 + 2f$$

$$2kx_0 = -2kx_1 + 2f$$

$$x_0 = \frac{f}{k} - x_1$$ (4 Point)

$$x_0 = A = \frac{\mu_s.m.g}{k} - x_1$$ (2 Point)

dimana telah diasumsikan $x_0 \le x_1$, atau $\mu_s \le \frac{2kx_1}{mg}$, $x_0 = A = \frac{\mu_s.m.g}{k} - 3x_2$

Saat f = maksimum, $f = \mu_s mg$, sehingga

$$A = \frac{\mu_s mg}{k} - x_1 \left(\mu_s \leq \frac{2kx_1}{mg} \right)$$

Jika $\mu_s > \frac{2kx_1}{mg}$, maka (atau $x_0 > x_1$) : (1 Point)

$$-k(x_0 - x_1) - f = -3k(x_2 + x_0) + f$$

$$k\left(x_1 - x_0\right) - f = -3k\left(x_2 + x_0\right) + f$$

$$kx_1 - kx_0 = -kx_1 - 3kx_0 + 2f$$

$$2kx_0 = -2kx_1 + 2f$$

$$x_0 = \frac{f}{k} - x_1$$

$$x_0 = A = \frac{\mu_s.m.g}{k} - x_1$$

5. (13 Point)

Diketahui : M = 70 kg (tanpa lengan)

m = 5 kg (lengan)

l = 1,4 m (panjang lengan)

- Momen inersia saat lengan terbuka :

$$I_1 = Mk^2 + \frac{1}{12}ml^2$$ (1 Point)

$(k = \text{jari} - \text{jari girasi badan})$

- Momen inersia saat lengan ditarik ke dalam

$$I_2 = (M + m)k^2$$ (1 Point)

- Kekekalan momentum anguler

$$I_1.\omega_1 = I_2\omega_2$$

$$\frac{I_1}{I_2} = \frac{\omega_2}{\omega_1} = 3$$ (2 Point)

Sehingga :

$$I_1 = 3I_2$$ (1 Point)

$$Mk^2 + \frac{1}{12}ml^2 = 3(M + m)k^2$$

$$Mk^2 + \frac{1}{12}ml^2 = 3Mk^2 + 3mk^2$$

$$\frac{1}{12}ml^2 = (2M + 3m)k^2$$

$$k = \left(\frac{ml^2}{12(2M + 3m)}\right)^{1/2}$$ (2 Point)

$$\frac{1}{12}.5.1,4^2 = (2.70 + 3.5)k^2$$

$$0,817 = 155k^2$$

$$k = 0,073$$

- E_K Skater = $\frac{1}{2}I\omega^2$

- Momentum anguler $L = I\,.\omega$ (tetap jika tidak ada torsi luar)

$$E_K = \frac{L^2}{2I} \Rightarrow \sqrt{2.I.E_K} = L = tetap$$ (2 Point)

$$\Rightarrow Jika\ I\ semakin\ kecil, maka\ E_K\ semakin\ besar$$

- Pertambahan energi :

$$2.I_1.E_{K_1} = 2I_2.E_{K_2}$$

$$\frac{I_2}{I_1} = \frac{E_{K_1}}{E_{K_2}}$$

$$\frac{1}{3} = \frac{E_{K_1}}{E_{K_2}} \Rightarrow E_{K_2} = 3E_{K_1}$$

$$\Rightarrow \Delta E_K = E_{K_2} - E_{K_1}$$ (1 Point)

$$\Delta E_K = 2.E_{K_1}$$

$$\Delta E_K = 2.\frac{1}{2} I_1.\omega_1^2$$

$$\Delta E_K = I_1.\omega_1^2$$ (2 Point)

$$I_1 = Mk^2 + \frac{1}{12} ml^2$$

$$I_1 = 70.0,073^2 + \frac{1}{12}.5.1,4^2$$

$$I_1 = 1,19\ kg.m^2$$

$$\omega_1 = 2rad/s$$

ΔE_K = *4,76 Joule* (1 Point)

6. (7 Point)

- $x_1 = \frac{L}{2}$

- $M.x_2 = M\left(\frac{L}{2} - x_2\right)$

  $x_2 = \frac{L}{4}$ (1 Point)

- $2.M.x_3 = M\left(\frac{L}{2} - x_3\right)$

  $x_3 = \frac{L}{6}$ (1 Point)

- $3.M.x_4 = M\left(\frac{L}{2} - x_4\right)$

  $x_4 = \frac{L}{8}$ (1 Point)

- $4.M.x_5 = M\left(\frac{L}{2} - x_5\right)$

  $x_5 = \frac{L}{10}$ (1 Point)

Jadi :

$$Z = \sum_{i=1}^{5} x_i = L\left\{\frac{1}{2} + \frac{1}{4} + \frac{1}{6} + \frac{1}{8} + \frac{1}{10}\right\}$$

$$= L\left\{\frac{4}{6} + \frac{3}{8} + \frac{1}{10}\right\}$$

$$= L\left\{\frac{32}{48} + \frac{18}{48} + \frac{1}{10}\right\}$$

$$= L\left\{\frac{500}{480} + \frac{48}{480}\right\}$$

$$= L.\frac{548}{480}$$

$$= \frac{137}{120}L$$

(3 Point)