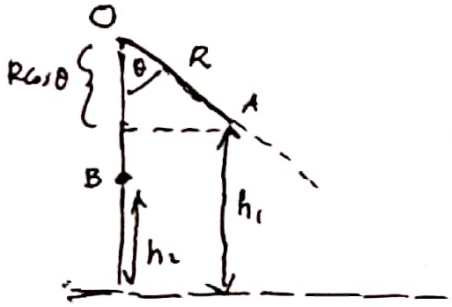
Solusi UTS 2 Fisika Dasar 1A ITB

oleh : Wawank

① **Momen Inersia**



$$I = \frac{1}{2}MR^2 + MR^2$$

$$= \frac{1}{2}(2)(0{,}7)^2 + (2)(0{,}7)^2$$

$$I = 1{,}47\ \text{kg m}^2$$

$$h_1 = 2R - R\cos\theta$$

$$h_2 = \frac{1}{2}R$$

$$K_{rotasi} = \frac{1}{2}I\omega^2$$

$$= \frac{1}{2}I\,\frac{V^2}{R^2}$$

$$= \frac{1}{2}(1{,}47)\,\frac{V^2}{(0{,}7)^2}$$

$$K_{tot} = 1{,}5V^2$$

Terapkan prinsip kekekalan Energi Mekanik di titik A dan B, maka :

$$\cos\theta = \cos \pi/3 = \frac{1}{2}$$

$$EM_A = EM_B$$

$$mgh_1 = mgh_2 + \frac{1}{2}I\omega^2$$

$$mg(2R - R\cos\theta) = mg\left(\frac{1}{2}R\right) + 1{,}5V^2$$

$$\frac{1}{2}mgR = 1{,}5V^2 \rightarrow \boxed{V = 2{,}16\ \text{m/s}}$$

(2) Hukum Newton kedua:

$$\Sigma F = ma$$

$$F_{app} - f_s = ma$$

$$f_s = 12 - (15)(0{,}16)$$

$$f_s = 3N$$

$$|\alpha| = \frac{a_{pm}}{R} = \frac{0{,}16}{0{,}12} = 3 \text{ rad/s}^2$$

$$|\tau| = I\,|\alpha|$$

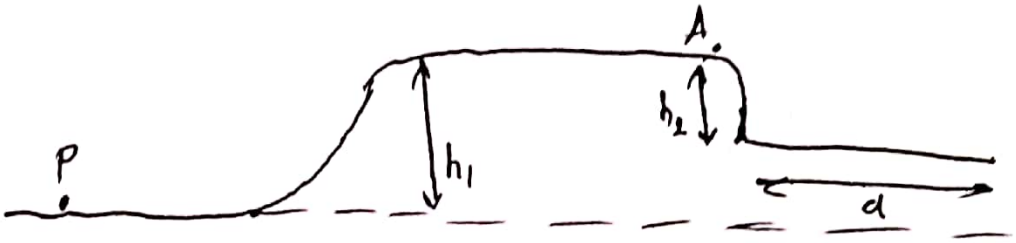
$$|F_r| = I\,|\alpha|$$

$$I = \frac{12\,(0{,}12)}{3}$$

$$I = 0{,}8 \text{ kgm}^2$$

Jawab : D

(3)



Saat bola jatuh parabola pada jarak d, maka :

$$x = V_0 \cos 0 \cdot t$$

$$d = V_0 t$$

$$V_0^2 = \frac{gd^2}{2h_2}$$

$$y = y_0 + V_{0y}t - \frac{1}{2}gt^2$$

$$0 = h_2 - \frac{1}{2}gt^2$$

$$t = \sqrt{\frac{2h_2}{g}}$$

Tinjau titik P dan titik A, maka :

$$\Sigma M_P = \Sigma M_A$$

$$\frac{1}{2}mV_p^2 + \frac{1}{2}I\omega_p^2 = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 + mgh_1$$

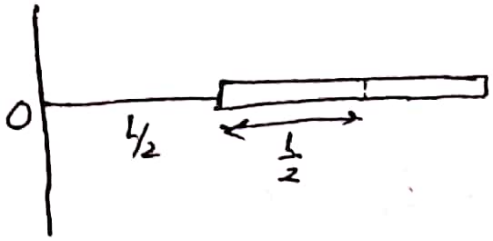
$$\frac{7}{10}mv^2 + mgh_1 = \frac{7}{10}mV_p^2$$

$$\frac{gd^2}{2h_2} + \frac{10}{7}gh_1 = V_p^2 \rightarrow V_p = 1{,}41 \text{ m/s}$$

Jawab : B

(4)

Momen Inersia batang homogen diputar pada poros :



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

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

$$= \frac{1}{12}ML^2 + ML^2$$

$$I = \frac{13}{12}ML^2$$

$$W = \Delta K$$

$$= K_f - K_i$$

$$= K_f - 0$$

$$= \frac{1}{2}I\omega^2$$

$$= \frac{1}{2}\left(\frac{13}{12}ML^2\right)\omega^2$$

$$= \frac{1}{2}\left(\frac{13}{12}\right)(2)(2)^2(10)^2 = 433{,}33 \text{ Joule}$$

Jawab : B

(6)

$$W = \Delta K$$

$$= K_f - K_i$$

$$= 0 - K_i$$

$$W = -\left(\frac{1}{2}I\omega^2 + \frac{1}{2}mV^2\right)$$

$$= -\left(\frac{1}{2}\left(0{,}4\,mR^2 \cdot \frac{V^2}{R^2} + \frac{1}{2}mV^2\right)\right.$$

$$= -(0{,}7)\,mV^2 = -28 \text{ Joule}$$

Jawab : B

(7) Berdasar prinsip Energi dalam Gerak harmonik Sederhana

$$E = E_p + E_k$$

$$\frac{1}{2}kA^2 = \frac{1}{2}k\left(\frac{1}{2}A\right)^2 + E_k$$

$$\frac{1}{2}kA^2 = \frac{1}{8}kA^2 + E_k$$

$$E_k = \frac{3}{8}kA^2$$

$$\frac{E_k}{E_p} = \frac{\frac{3}{8}kA^2}{\frac{1}{8}kA^2} = \frac{3}{1}$$

Jawab : C

(8) $E = \frac{1}{2}kA^2$

$0{,}12 = \frac{1}{2}k(0{,}05)^2$

$k = 160\ N/m$

$\omega_1 = \sqrt{\frac{k}{m}}$

$\omega_1 = \sqrt{\frac{160}{4{,}04}} = 63{,}245\ rad/s$

$$\frac{\omega_2}{\omega_1} = \frac{\sqrt{\frac{k}{m_2}}}{\sqrt{\frac{k}{m_1}}} = \sqrt{\frac{k}{2m} \times \frac{m}{k}}$$

$$\frac{\omega_2}{\omega_1} = \frac{1}{\sqrt{2}} \rightarrow \omega_2 = \frac{1}{\sqrt{2}}\omega_1$$

$$= 44{,}7$$

$\omega_2 = 45\ rad/s$

Jawab : B

(9) $T = 10\,s \rightarrow \omega = \frac{2\pi}{T} = \frac{2\pi}{10} = 0{,}2\pi\ rad/s$

Saat $t = 1\,s \rightarrow x = 0$, maka

$$0 = A\cos(\omega t + \phi)$$

$$0 = A\cos(0{,}2\pi(1) + \phi) \rightarrow 0{,}2\pi + \phi = 0{,}5\pi$$

$$\phi = 0{,}3\pi$$

Saat $t = 2\,s \rightarrow V = 2\,m/s$.

$$V = \omega A \sin(0{,}2\pi(2) + \phi)$$

$$2 = 0{,}2\pi\, A \sin(0{,}4\pi + 0{,}3\pi)$$

$$A = 3{,}93\ m$$

Jawab : A

(10) Modulus Young untuk maksimum $\Delta L = 4\,mm$.

$$E = \frac{\frac{F}{A}}{\frac{\Delta L}{L}} \rightarrow E = \frac{F}{A} \times \frac{L}{\Delta L}$$

$$= \frac{1000 \cdot 10}{8\times10^{-6}} \cdot \frac{10}{4\times10^{-3}}$$

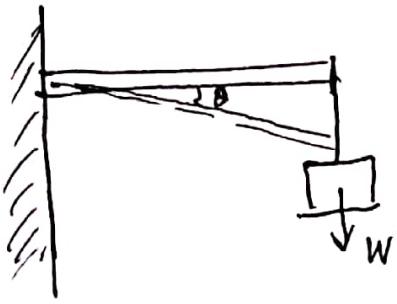
$$E = 3125 \times 10^{7}\ Pa$$

Jadi, banyaknya potongan kawat : $\frac{E}{E_0} = \frac{3125\times10^{7}}{200\times10^{7}}$

$= 15{,}625 \approx 16$

Jawab : E

(11)



Gaya pegas :

$$F = -kx\,\hat{j}$$

Gaya pemulih pada kasus ini adalah

$$F = -T\sin\theta\,\hat{j}$$

maka : $-T(\tan\theta)\,\hat{j}$

karena θ kecil, $\approx -T\frac{y}{L}\,\hat{j}$

$\sin\theta \approx \tan\theta$

$$F = -\left(\frac{T}{L}\right)y$$

maka : $k = \left(\frac{T}{L}\right)$

$$\omega = \sqrt{\frac{k}{m}} = \sqrt{\frac{T/L}{m}} = \sqrt{\frac{T}{mL}}$$

$$\omega^2 = \frac{I}{mL} \rightarrow T = \omega^2 mL$$

$$= 80^2(60)(0{,}03)$$

$$T = 11520\ N$$

$$G = \frac{\frac{F}{A}}{\frac{\Delta x}{L}}$$

$$G = \frac{\frac{T\tan\theta}{A}}{\tan\theta} = \frac{T}{A} = \frac{18520}{0{,}006} = 1{,}92 \times 10^9\ Pa$$

Jawab : C

(12) $V = \frac{\omega}{k} = \sqrt{\frac{T}{\mu}}$

$\left(\frac{\omega}{k}\right)^2 = \frac{T}{10^{-3}/m}$

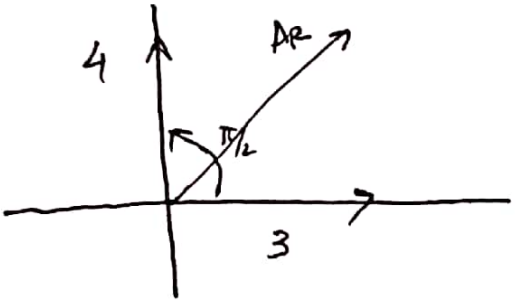
$\left(\frac{\omega}{k}\right)^2 = 10^3 T$

$\left(\frac{100\pi}{10\pi}\right)^2 = 10^3 T$

$T = 0{,}1\ N$

Jawab : A

(13)



Dengan cara fasor, $A_R = \sqrt{3^2+4^2} = 5$ satuan

Jawab : B

(14) $y = y_1 + y_2 = 6\sin(\pi x)\cos(0{,}5\pi t) + 6\sin(\pi x)\cos(0{,}5\pi t)$

$y(x,t) = 12\sin(\pi x)\cos(0{,}5\pi t)$

saat simpangan maks → $\cos(0{,}5\pi t) = 1$

maka : $y_m = 12\sin(\pi(0{,}1))$

$= 3{,}71$ cm

Jawab : E

(15) $A_{resultan} = 2A \cos 2\pi \left(\frac{f_1 - f_2}{2}\right)t$

Beda fase 2 gelombang $\rightarrow \phi = 2\pi (f_1 - f_2)t$

$A_R = 1{,}25\, A_0$

$2A_0 \cos\left(\frac{\phi}{2}\right) = 1{,}25\, A_0$

$\cos\left(\frac{\phi}{2}\right) = 0{,}625$

$\frac{\phi}{2} = 51{,}3^\circ$

$\phi = 102{,}64^\circ$

Jawab : A

(16) $f = f\left(\frac{v + 0}{v - v_s}\right)$

$= 1000\left(\frac{330 + 0}{330 + 15}\right)$

$f = 957\ Hz$

Jawab : E

(17) $\Sigma F_y = 0$

$mg - F_a = 0$

$mg = F_a$

$\rho_b V g = \rho_f V_s g$

$\frac{\rho_b}{\rho_f} = \frac{V_s}{V}$

$0{,}91 = \frac{V_s}{V} \rightarrow V_s = 0{,}91V$

Volume yg tampak $= V - V_s$

$(1 - 0{,}91)V$

$= 9\%\, V_{total}$

Jawab : E

(18)

$m = \rho V_s$

$= \rho \left(\frac{1}{14} \left(\frac{4\pi}{3} (2\times10^{-2})^3 - (1\times10^{-2})^3 \right] \right.$

$= 900\,(0{,}299)\left(8\times10^{-6} - 1\times10^{-6}\right)$

$= 1884 \times 10^{-6}$ kg

$m = 1{,}88 \times 10^{-3}$ kg

Jawab : C

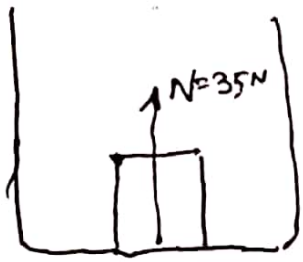
$\Sigma F_y = 0$

$mg - \rho g V_s = 0$

$mg = \rho g V_s$

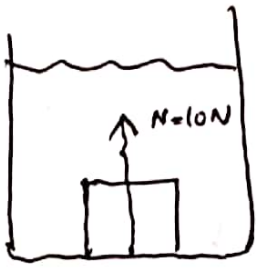
$m = \rho V_s$

(19)



$N - mg = 0$

$mg = 35N$



$\Sigma F_y = 0$

$mg - N - F_a = 0$

$F_a = mg - N$

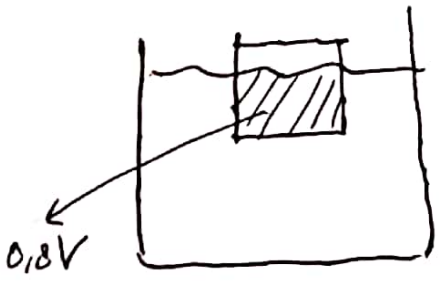
$= 35 - 10$

$F_a = 25N$

$\rho_f V g = 25$

$800\ V(10) = 25$

$V = 3{,}125 \times 10^{-3}\ m^3$



$\Sigma F_y = 0$

$F_a - mg = 0$

$F_a = mg$

$\rho_f (0{,}8)(3{,}125\times10^{-3})g = 35$

$\rho_f = 1.400\ kg/m^3$

Jawab : E

(20)

Dengan prinsip bernoulli :

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$$

$$P_1 - P_2 = \frac{1}{2}\rho\left(v_2^2 - v_1^2\right)$$

$$2\times10^4\ Pa = \frac{1}{2}.1000\left[v_2^2 - \left(\frac{A_1 v_2}{A_1}\right)^2\right]$$

$$= 500\left(v_2^2 - \left(\frac{\pi.(3\times10^{-2})^2}{\pi(6\times10^{-2})^2}.v_2^2\right]\right.$$

$$40 = 0{,}175\, v_2^2$$

$$v_2 = 7{,}3\ m/s$$

$$Q = A_2 v_2$$

$$= \pi(3\times10^{-2})^2 . 7{,}3$$

$$Q = 206{,}38\times10^{-4} = 0{,}02 = 2\times10^{-2}\ m^3/s$$

Untuk tipe soal lain, $d_1 = 18\ cm$

$r_1 = 9\ cm$

maka: $v_2 = 6{,}36\ m/s$

$$Q = A_2 v_2 = 1{,}8\times10^{-2}\ m^3/s$$

Jawab : C

(21) Proses berlangsung secara Isotermal

$$W = nRT \ln \frac{V_2}{V_1}$$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$P_1\ 64\ L = 0{,}4 P_1 V_2$$

$$V_2 = 160\ L$$

untuk 4 mol gas : $W = 4\ (8{,}31) \ln \frac{V_2}{V_1}$

$$= 4(8{,}31) \ln \left(\frac{160\ L}{64\ L}\right)$$

$$W = 83{,}1\ J$$

untuk 0,2 mol :

$$W = 0{,}2\ (8{,}31) \times 2{,}5$$

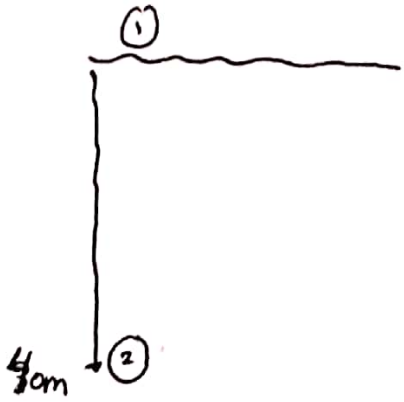
$$= 4{,}155\ \text{Joule}$$

maka :

$$\frac{W \text{ total } (4 \text{ mol})}{W_{0{,}2 \text{ mol}}} = \frac{83{,}1\ J}{4{,}155\ J} = 20 \text{ kalan}$$

Jawab : C

(22)



Gelembung udara diasumsikan gas ideal, maka

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$\frac{P_0 V_1}{300} = \frac{(P_0 + \rho g h)\, 15\ cm^3}{280}$$

$$280\, P_0 V_1 = 300 P_0 (15\ cm^3) + 300 \rho g h (15\ cm^3)$$

$$= 300 (P_0 + \rho g h)\, 15\ cm^3$$

$$280.10^5 V_1 = 300 \left(10^5 + \tfrac{4}{7}.10^5\right) 15\ cm^3$$

$$V_1 = 80{,}3\ cm^3$$

Jawab: A

(23)

$$E = \frac{3}{2} n R T$$

$$= \frac{3}{2}(3)\,(8{,}314)\,(298)$$

$$E = 11149\ J$$

Jawab: C

(24)

$$k = \frac{Q_L}{W}, \quad \varepsilon = \frac{W}{Q_H} \rightarrow W = 0{,}6\, Q_H$$

$$k = \frac{Q_L}{W} = \frac{Q_H - W}{0{,}6\, Q_H} = \frac{Q_H - 0{,}6\, Q_H}{0{,}6\, Q_H} = \frac{0{,}4\, Q_H}{0{,}6\, Q_H}$$

$$k_C = 0{,}67$$

Jawab: C

(25) $W = P\Delta V$

$= nR\Delta T$

$= 2(8{,}314)(420-320)$

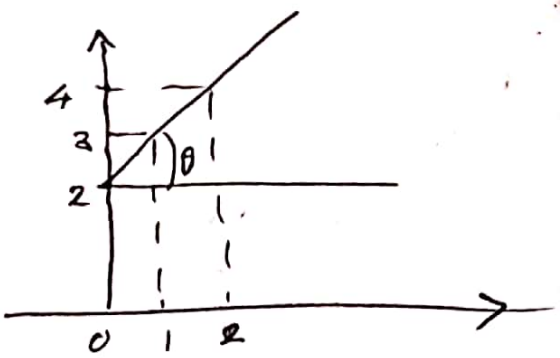
$W = 1663\,J$

Jawab: A

(26) Posisi tiap waktu

$\vec{r} = \vec{r}_0 + vt$

$\vec{r} = 2\hat{j} + \left(\frac{4{,}15}{\sqrt{2}}t\,\hat{i} + \frac{4{,}15}{\sqrt{2}}t\,\hat{j}\right)$



$v = 4{,}5\cos\theta\,\hat{i} + 4{,}5\sin\theta\,\hat{j}$

$v = \frac{4{,}5}{\sqrt{2}}\hat{i} + \frac{4{,}5}{\sqrt{2}}\hat{j}$

$\vec{p} = \frac{6{,}75}{\sqrt{2}}\hat{i} + \left(\frac{6{,}75}{\sqrt{2}}\hat{j}\right)$

$\downarrow$

$p = mv$

Maka: $L = \vec{r} \times \vec{p} =$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{4{,}15t}{\sqrt{2}} & \left(\frac{4{,}15}{\sqrt{2}}t+2\right) & 0 \\ \frac{6{,}75}{\sqrt{2}} & \frac{6{,}75}{\sqrt{2}} & 0 \end{vmatrix}$$

$\vec{L} = 9{,}5\ kgm/s\ \hat{k}$

Jawab : A

(27)

$f_1 = \left(\frac{V - V_D}{V + V_S}\right) f$ ---- 1) frekuensi dari S saat 1 km dari dinding

$f_2 = \left(\frac{V + V_D}{V - V_S}\right) f$ ---- 2) → saat menerima pantulan

bagi pers (2) dan pers (1)

$$\frac{f_2}{f_1} = \frac{\left(\frac{V+V_D}{V-V_S}\right) f}{\left(\frac{V-V_D}{V+V_S}\right) f}$$

$$\frac{1000}{900} = \left(\frac{\frac{340+V_D}{340}}{\frac{340-V_D}{340}}\right)$$

$$\frac{10}{9} = \frac{340+V_D}{340-V_D}$$

$V_D = 17{,}89$ | Jawab : A

(28)

$P_1 + \frac{1}{2}\rho V_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho V_2^2 + \rho g h_2$

$Q = A_1 V_1$
$= 150 \times 10^{-4} (4{,}236)$

$\frac{1}{2}\rho (V_1^2 - V_2^2) = P_2 - P_1$

$\frac{1}{2}(800)\left(V_1^2 - \left(\frac{150}{950} V_1\right)^2\right) = 7 \times 10^3 \text{ Pa}$

~~$Q = A_1 V_1$~~

$336{,}84 V_1^2 = 7 \times 10^3 \text{ Pa} \rightarrow$ ~~V_1~~ = ~~[illegible]~~ m/s

$V_1 = 4{,}236$

Fluks massa = $Q \cdot \rho = 50{,}84$ kg/s

Jawab : E

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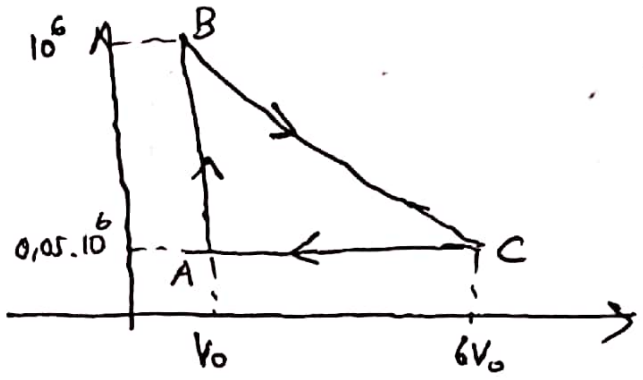

$\gamma = \frac{c_p}{c_v} = \frac{5/2}{3/2}$

$\gamma = \frac{5}{3} = 1{,}67$

Efisiensi Siklus ABCA

$$\varepsilon = \frac{W}{Q_{in}} = \frac{Q_{in} - Q_{out}}{Q_{in}}$$

$$\varepsilon = 1 - \frac{Q_{out}}{Q_{in}}$$

$$\varepsilon = 1 - \left| \frac{n C_p \Delta T}{n C_v \Delta T} \right|$$

$$= 1 - \left| \frac{\frac{5}{2} R (T_A - T_C)}{\frac{3}{2} R (T_B - T_A)} \right|$$

$$= 1 - \left| \frac{\frac{5}{3} (-5 T_A)}{19 T_A} \right|$$

$\varepsilon = 0{,}56$

$\varepsilon = 56\%$

Jawab : D

tinjau titik B dan C

$P_B V_B^{\gamma} = P_C V_C^{\gamma}$

$10^4 V_0^{\gamma} = P_C (6V_0)^{\gamma}$

$10^4 = P_C \, 6^{1{,}67}$

$0{,}05.10^4 = P_C$

tinjau A dan B

$\frac{P_A V_A}{T_A} = \frac{P_B V_B}{T_B}$

$\frac{0{,}05.10^6}{T_A} = \frac{10^6}{T_B}$

$T_A = 0{,}05 \, T_B$

$T_B = 20 \, T_A$

titik A dan C

$\frac{P_A V_A}{T_A} = \frac{P_C V_C}{T_C}$

$\frac{V_0}{T_A} = \frac{6V_0}{T_C}$

$6T_A = T_C$

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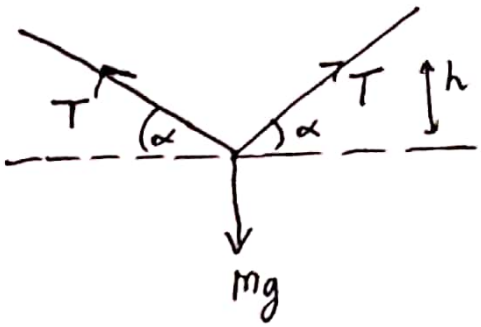

$\Sigma F_y = 0$

$2T\sin\alpha - mg = 0$

$2T\sin\alpha = mg$ ----- 1)

Panjang teregang sejauh, $l = \frac{l_o}{\cos\alpha}$

tiap bagian teregang sebesar faktor $\left(\frac{1}{\cos\alpha}\right)$

Maka, sesuai hukum Hooke,

$T = k\Delta L = k(l - l_o)$

$T = k l_o \left(\frac{1}{\cos\alpha} - 1\right)$ ---- 2)

Substitusi persamaan (2) ke persamaan (1),

$2k l_o (1 - \cos\alpha)\tan\alpha = mg$

$\tan\alpha = \frac{h}{l_o} = \frac{60 \times l_o}{1,8}$

$k = mg\left[2 l_o \tan\alpha (1 - \cos\alpha)\right]^{-1}$

$\alpha = 1,9^\circ$

$\cos\alpha = 0,999$

$= 70(10)\left[2(1,8)(0,1033)(1-0,99)\right]^{-1}$

$k = 6,47 \times 10^3$

Modulus elastis $= \frac{\frac{F}{A}}{\frac{\Delta L}{L}} = \frac{F}{A} \times \frac{L}{\Delta L} = \frac{F}{\Delta L}\frac{L_o}{A}$

$= k\frac{L_o}{A} = 6,477 \times 10^3 \frac{(1,8)}{\pi(0,05 \times 10^{-3})^2}$

$G = 1,48 \times 10^6\ N/m^2$

Jawab : A