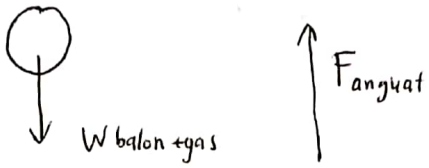
Solusi Tutorial 7 Fisika Dasar 1B ITB

oleh: Wawan K.

A. Pertanyaan

(1)



kita bandingkan $W_{balon+gas}$ dengan F_{angkat}

.) $W_{balon+gas} = mg$

$= 2(9{,}8)$

$= 19{,}6\ N$

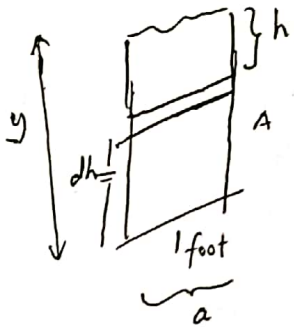
.) $F_{angkat} = \rho_{udara} V_{balon} g$

$= 1{,}3\ (5)\ (9{,}8)$

$= 63{,}7\ N$

karena $F_a > W$, maka balon akan naik

(2) .) SA = besar gaya pada dinding samping A



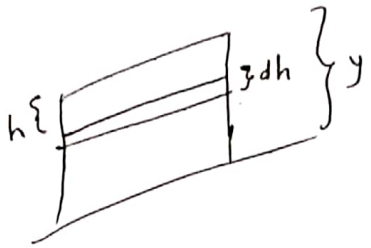
$F = PA$

$= \int P\,dA = \int \rho g h\, a\, dh$

$= \rho g a \int_0^y h\, dh$

$SA = F_{SA} = \rho g a \left(\frac{1}{2} y^2\right) = \frac{\rho g a}{2} y^2$

(2) ·) SB = PA



$F_{SB} = \int \rho g h a \, dh$

$F_{SB} = \rho g a \frac{1}{2} h^2 \Big|_0^Y$

$SB = \frac{\rho g a}{2} Y^2$

·) BA = PA

$= \rho g h A$

$= \rho g Y (3 \times 1) feet^2$

$BA = 3 \rho g Y \; feet^2$

·) BB = PA

$= \rho g h (6 \times 1) feet^2$

$BB = 6 \rho g Y \; feet^2$

Jadi, SA = SB dan 2BA = BB

Jawaban : D

(3) Tekanan paling besar terjadi di A.

$P + \frac{1}{2} \rho V^2 + \rho g h = konstan$

Pada titik A, luas penampang besar, berarti V melambat, dan h berada di titik terendah, hal ini berarti P (tekanan) akan memiliki nilai terbesar.

$P + \frac{1}{2} \rho V^2 + \rho g h = konstan$

P ↓ besar, $\frac{1}{2} \rho V^2$ ↓ kecil, $\rho g h$ ↓ kecil

④ Pada ketinggian lebih rendah tekanan air bernilai lebih besar karena tekanan bertambah dengan bertambahnya kedalaman (kebawah)

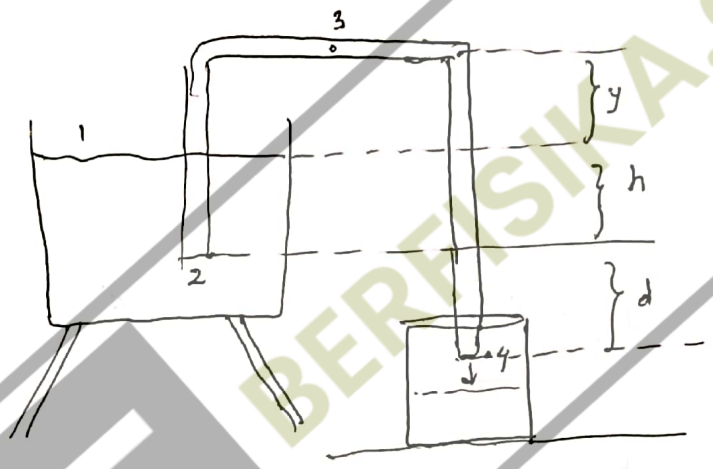
$$P + \frac{1}{2}\rho v^2 + \rho g h = \text{konstan}$$

pada lantai bawah :

$$P + \frac{1}{2}\rho v^2 + \rho g h = \text{konstan}$$

P ↓ maksimum, $\frac{1}{2}\rho v^2$ ↓ terkecil ($v = 0$), $\rho g h$ ↓ maksimum

⑤



*) Syarat air dapat mengalir adalah P_2 harus lebih besar dari P_3 atau $P_2 > P_3$.

- kita akan buktikan bahwa $P_2 > P_3$, sehingga air dapat berpindah pada konfigurasi sifon seperti itu.

*) Tinjau titik 1 dan 2

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2 \quad \text{dengan } v_1 = 0 \text{ dan } P_1 = P_0$$

$$P_0 + 0 + \rho g (h+d) = P_2 + \frac{1}{2}\rho v_2^2 + \rho d g$$

$$\boxed{P_2 = P_0 + \rho g h - \frac{1}{2}\rho v_2^2}$$

(5) ·) Tinjau titik 1 dan 4

$$P_1 + \frac{1}{2}\rho V_1^2 + \rho g h_1 = P_4 + \frac{1}{2}\rho V_4^2 + \rho g h_4$$

$$P_0 + 0 + \rho g(h+d) = P_0 + \frac{1}{2}\rho V_4^2 + 0$$

$$V_4 = \sqrt{2g(h+d)}$$

-) Tinjau titik 3 dan 4

$$P_3 + \frac{1}{2}\rho V_3^2 + \rho g h_3 = P_4 + \frac{1}{2}\rho V_4^2 + \rho g h_4 \quad \text{dengan } (V_3 = V_4,\ P_4 = P_0,\ h_4 = 0)$$

$$P_3 + \rho g(y+d+h) = P_0$$

$$P_3 = P_0 - \rho g(y+h+d)$$

kemudian P_2 akan kita bandingkan P_3.

$$P_2 = P_0 + \rho g h - \frac{1}{2}\rho V_2^2$$

$$P_2 = P_0 + \rho g h - \frac{1}{2}\rho(2g(h+d))$$

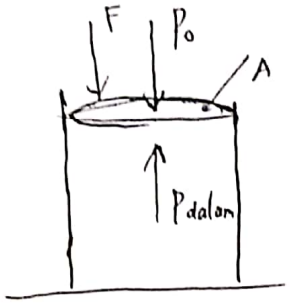
$$= P_0 + \rho g h - \rho g h - \rho g d$$

$$P_2 = P_0 - \rho g d$$

Jadi, dapat kita simpulkan $P_2 > P_3$

Sehingga air dapat berpindah

B. SOAL

① 

$P_{dalam} = P_0 + P'$

$= 1 \times 10^5 + \frac{F}{A}$

$= 10^5 + 6{,}2 \times 10^4$

$= 10^5 + 0{,}6 \times 10^5$

$P_{dalam} = 1{,}6 \times 10^5$ Pa

② $P_1 = P_2$

$\frac{F_1}{A_1} = \frac{F_2}{A_2}$

$\frac{45}{\pi r_1^2} = \frac{F_2}{\pi r_2^2}$

$\left(\frac{r_1}{r_2}\right)^2 = \frac{F_2}{45} \rightarrow F_2 = 45\ (8)^2 = 2880\ N$

③ Kita ketahui bahwa:

$P_{atmosfere} = P_{pipet} + \rho gh$

a) $P_{pipet} = P_0 - \rho gh$

$= 1{,}013 \times 10^5 - (1200)(9{,}8)(0{,}15)$

$P_{pipet} = 9{,}95 \times 10^4$ Pa

(3) b) $P_{pipet} = P_0 - \rho gh$

$= 1{,}013 \times 10^5 - (1200)(9{,}8)(0{,}10)$

$P_{pipet} = 1{,}001 \times 10^5$ Pa

(4) $\Sigma F_y = 0$

$F_{apung} - W = 0$

$F_a = W$

$\rho_{air} V_{kayu}\, g = (m_{kayu} + m_{cu})g$

$\rho_{air} \dfrac{m_{kayu}}{\rho_{kayu}} = m_{kayu} + m_{cu}$

$m_{cu} = m_{kayu}\left(\dfrac{\rho_{air}}{\rho_{kayu}} - 1\right)$

$= 0{,}40 \text{ kg}\left(\dfrac{1000}{600} - 1\right)$

$m_{cu} = 0{,}27 \text{ kg}$

(5) Dengan menerapkan persamaan kontinuitas untuk fluida tidak terkompresi,

$(Av)_{aorta} = (Av)_{arteri}$

$V_{arteri} = \dfrac{A_{aorta}}{A_{arteri}} V_{aorta} = \dfrac{\pi (1{,}2 \text{ cm})^2}{2 \text{ cm}^2}(40 \text{ cm/s})$

$V_{arteri} = 90{,}5 \text{ cm/s} = 0{,}9 \text{ m/s}$

(6)

$$A_1 V_1 = A_2 V_2$$

$$V_1 = \left(\frac{A_2}{A_1}\right) V_2$$

$$V_1 = \left(\frac{0{,}07\ m^2}{0{,}05\ m^2}\right) V_2$$

$$V_1 = 1{,}40\, V_2$$

kita terapkan persamaan bernoulli pada titik 1 dan 2

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

$$P_1 + \tfrac{1}{2}\rho (1{,}4\, V_2)^2 = P_2 + \tfrac{1}{2}\rho V_2^2$$

$$V_2 = \sqrt{\frac{2(P_2 - P_1)}{\rho (1{,}40)^2 - 1}}$$

$$= \sqrt{\frac{2(130)}{1{,}1\ (1{,}40)^2 - 1}}$$

$$= \sqrt{\frac{260}{1{,}156}}$$

$$= 14{,}99$$

$$V_2 \approx 15\ m/s$$

(7) Hukum Hooke : $W = kx$ ---- 1) kemudian $F_B - W = 2kx$ ---- 2)

$$F_B - W = 2W$$

$$F_B = 3W = 3\rho_w g V_{air} \qquad \rho_w = \rho_{water}$$

Sehingga Volume balok :

$$V_{air} = \frac{3m}{\rho} = \frac{3(6)}{10^3} = 1{,}80 \times 10^{-2}\ m^3$$

(7) Volume kayu didalam balok, $\rho_{kayu} = 840\ kg/m^3$ → Lihat Cutnel Chpter II

$$V_{kayu} = \frac{M}{\rho} = \frac{6}{840}$$

$$V_{kayu} = 7{,}14 \times 10^{-3}\ m^3$$

Volume (rongga) balok :

$$V - V_{kayu} = 1{,}08 \times 10^{-2}$$

Sehingga, presentase dari rongga balok

$$\frac{1{,}10 \times 10^{-2}}{1{,}8 \times 10^{-2}} \times 100\% = 60\ \%$$

(8) P_B : Tekanan sayap bawah

P_T : Tekanan Sayap atas

Gaya angkat $(F) = \Delta P_A$ atau

$$W = (P_B - P_T)A$$

Dengan prinsip Bernoulli :

$$P_B + \frac{1}{2}\rho V_B^2 + \rho g h_B = P_T + \frac{1}{2}\rho V_T^2 + \rho g h_T$$

$h_B = h_T$ → kita abaikan (ketebalan dianbaikan)

$$P_B + \frac{1}{2}\rho V_B^2 = P_T + \frac{1}{2}\rho V_T^2 \text{ atau}$$

$$P_B - P_T = \frac{1}{2}\rho V_T^2 - \frac{1}{2}\rho V_B^2$$

(8) Dengan mengetahui bahwa :

$$W = (P_B - P_T)A \quad \text{maka :}$$

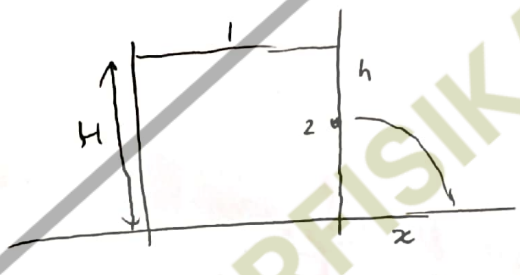
$$W = (P_B - P_T)A$$

$$= \frac{1}{2}\rho(V_T^2 - V_B^2)A$$

$$= \frac{1}{2}(1{,}29)\left[62^2 - 54^2\right](16)$$

$$\boxed{W = 9600\,N}$$

(9) a)



$V_1 \approx 0$

Dengan menerapkan prinsip bernoulli pada titik 1 dan 2 :

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

$$P_0 + 0 + \rho g H = P_0 + \frac{1}{2}\rho V_2^2 + \rho g(H-h)$$

$$\rho g h = \frac{1}{2}\rho V_2^2$$

$$V_2 = \sqrt{2gh}$$

Kemudian, tetapkan parabola.

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

$$0 = (H-h) - \frac{1}{2}gt^2 \rightarrow t = \sqrt{\frac{2(H-h)}{g}}$$

Sehingga

(9)

$$x = V_2 t$$

$$= \sqrt{2gh}\ \sqrt{\frac{2(H-h)}{g}}$$

$$= 2\sqrt{h(H-h)}$$

$$x = 2\sqrt{12(40-12)} = 37\,cm$$

b) dari persamaan no a)

$$x^2 = \left(2\sqrt{h(H-h)}\right)^2$$

$$x^2 = 4h(H-h)$$

$$h^2 - Hh + \frac{x^2}{4} = 0$$

Solusinya : $h = \frac{H \pm \sqrt{H^2 - x^2}}{2}$

kedua akar memungkinkan selama $x \leq H$. jika akar yg besar adalah h_1 (positif) dan yang kecil adalah h_2 (negatif), maka :

$$h_1 + h_2 = \frac{H + \sqrt{H^2 - x^2}}{2} + \frac{H - \sqrt{H^2 - x^2}}{2}$$

$$= H$$

maka salah satu akar berhubungan dengan akar yg lainnya.

misal diberi nama h' dan h

dengan $h' = H - h$

$h' = 40\,cm - 12\,cm = 28\,cm$

(9) c) Nilai maksimum dari persamaan :

$$f = x^2 = 4h(H-h)$$

$$\frac{df}{dh} = \frac{d}{dh}\left(4h(H-h)\right)$$

$$0 = 4H - 8h$$

$$h = \frac{H}{2}$$

$$h = \frac{40\,cm}{2} = 20\,cm$$

(10) $P_A + \frac{1}{2}\rho V_A^2 + \rho g h_A = P_B + \frac{1}{2}\rho V_B^2 + \rho g h_B$ $\quad h_A = h_B$

$V_A = 0$

$$P_A - P_B = \frac{1}{2}\rho V_B^2$$

$$\Delta P = \frac{1}{2}\rho V^2$$

- kemudian pada keadaan statis di pipa U

$$P_A = P_B + \rho g \Delta h$$

$$P_A - P_B = \rho g \Delta h$$

Sehingga :

$$\frac{1}{2}\rho_u V^2 = \rho_{Hg} g \Delta h$$

$$V = \sqrt{\frac{2\rho_{Hg} g \Delta h}{\rho_{udara}}} = 103\ m/s$$