The University of Jordan/Physics Department
Solutions to chapter 10
Giancoli 7th edition
Prof. Mahmoud Jaghoub

5] $m_b = 35.00\ g$

$M_W = 98.44 - 35.00 = 63.44\ g$

$M_F = 89.22 - 35.00 = 54.22\ g$

$$SG = \frac{\rho_F}{\rho_W} = \frac{M_F/V}{M_W/V} = \frac{M_F}{M_W} \simeq 0.855$$

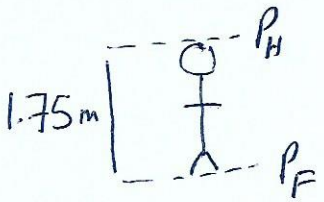
10] $P_F = P_H + \rho_{blood} g h$

$P_F - P_H = \rho_{blood} g h$

$= (1059.5)(9.8)(1.75)$

$= 18170\ Pa$

$= 18170\ Pa \left(\frac{760\ mm\,Hg}{1.013 \times 10^5\ Pa}\right)$



$\therefore\ P_F - P_H \simeq 136.3\ mm\,Hg.$

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11] (a) $F_{top} = PA$

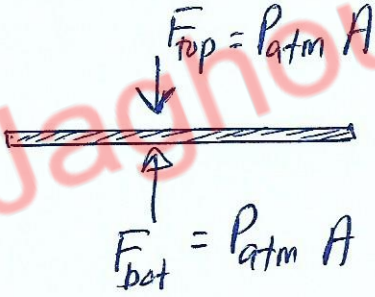
$= (1.013 \times 10^5 \frac{N}{m^2})(1.7 \times 2.6\ m^2)$

$= 447746\ N$

(b) The thickness of the table is small $\Rightarrow$ atmospheric pressure on the underside of the table is the same as its value on the top surface.

$\Rightarrow F_{bot} = PA = 447746\ N$ as in part (a).

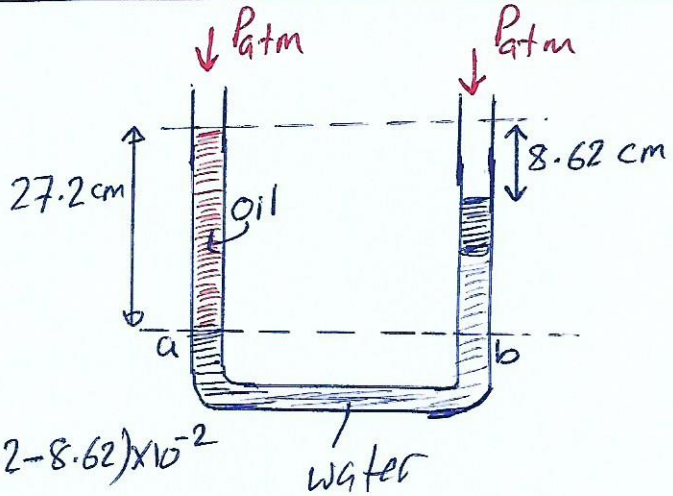
$\Rightarrow$ Net force on table due to atmospheric pressure is $\vec{F}_{top} - \vec{F}_{bot} = 0$.



18]

Points a and b have the same pressure

$P_a = P_b$



$P_{atm} + \rho_{oil} g (27.2 \times 10^{-2}) = P_{atm} + \rho_w g (27.2 - 8.62) \times 10^{-2}$

$\therefore \rho_{oil} (27.2) = \rho_w (18.58)$

$\therefore \rho_{oil} = 1000 \times \frac{18.58}{27.2} \simeq 683\ kg/m^3$.

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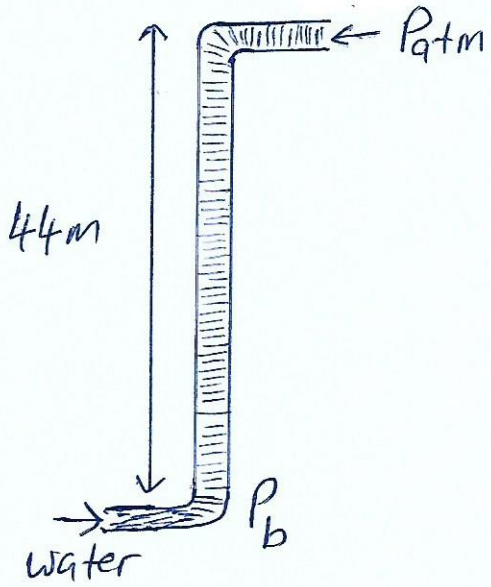
20]



$$P_b = P_{atm} + \rho_w g h$$

$$P_b - P_{atm} = \rho_w g h$$

$$P_{gauge} = (1000)(9.8)(44)$$

$$= 431200 \text{ Pa}$$

$$= 431200 \text{ Pa} \times \frac{760 \text{ mm Hg}}{1.013 \times 10^5 \text{ Pa}}$$

$$P_{gauge} = 3235 \text{ mm Hg}$$

$$= 431200 \text{ Pa} \times \frac{1 \text{ atm}}{1.013 \times 10^5 \text{ Pa}} = 4.2 \text{ atm}$$

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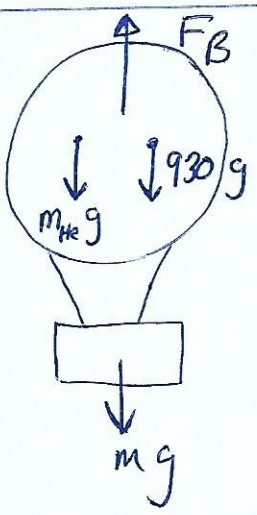
26] Static equilibrium



$$\uparrow \quad F_B - m_{He}g - 930g - mg = 0$$

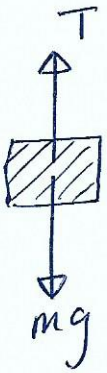
$$\rho_{air} V g - \rho_{He} V g - 930g = mg$$

$$(\rho_{air} - \rho_{He})\left(\frac{4}{3}\pi (7.15)^3\right) - 930 = m$$

$$(1.29 - 0.179)\left(\frac{4}{3}\pi (7.15)^3\right) - 930 = m$$

$$\Rightarrow m = 771 \text{ kg}.$$

27]

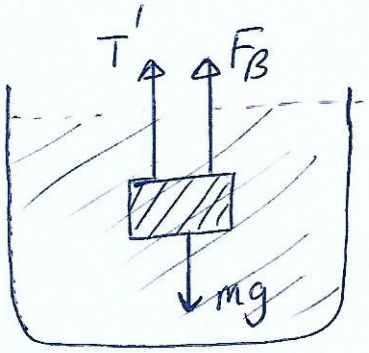


T is the true weight that the balance reads in air (we ignore the buoyant force due to air on the metal as it is too small).

static equilibrium $\Rightarrow$

$$T = mg \quad - (1)$$

[Note $T = 63.5 \times 10^{-3} g$ true weight]



T' is the apparent weight read by the balance.

$$T' = 55.4 \times 10^{-3} g$$

static equilibrium $\Rightarrow$

$$F_B + T' - mg = 0$$

$$\therefore \quad mg - T' = F_B \quad - (2)$$

(2)/(1) $$\frac{mg - T'}{T} = \frac{F_B}{mg} = \frac{\rho_F V g}{\rho_o V g} = \frac{\rho_F}{\rho_o}$$

$$\Rightarrow \frac{63.5 \times 10^{-3} g - 55.4 \times 10^{-3} g}{63.5 \times 10^{-3} g} = \frac{1000}{\rho_o}$$

$$\Rightarrow \rho_o = 7.84 \times 10^{3} \ kg/m^3$$

$\Rightarrow$ it is made of iron or steel.

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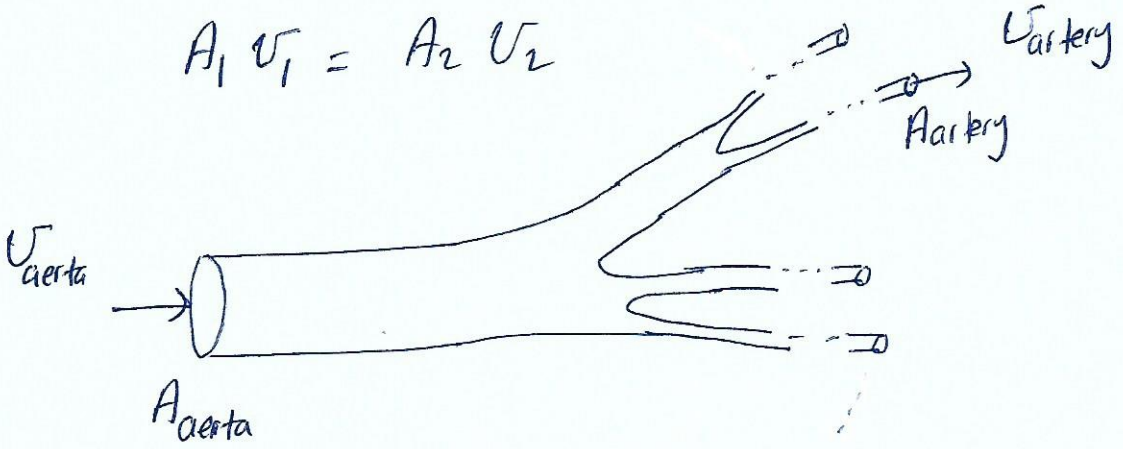
38] use the continuity equation

$$A_1 v_1 = A_2 v_2$$



$$A_{aorta}\, v_{aorta} = A_{arteries}\, v_{artery}$$

$A_{arteries}$: total area of all arteries

($A_{arteries} = N\, A_{artery}$)

$$v_{artery} = \frac{A_{aorta}}{A_{arteries}} v_{artery} = \frac{\pi r_{aorta}^2}{2\times10^{-4}} \times 0.4$$

$$\simeq 0.9 \text{ m/s}$$

(we assumed all arteries to have the same cross sectional area.)

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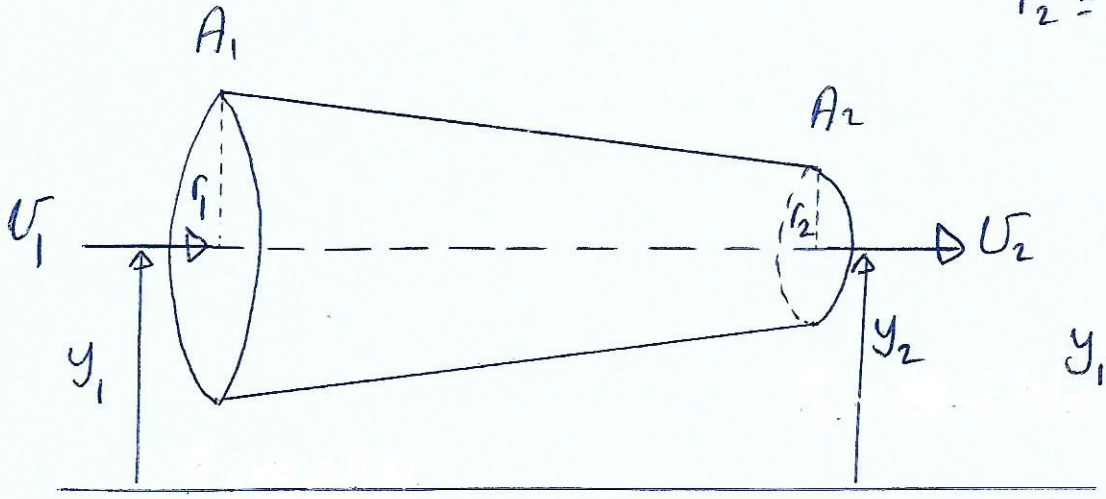
45] gauge pressure $P_{g1} = 33.5\ kPa$ gauge pressure $P_{g2} = 22.6\ kPa$ $r_1 = 3.00\ cm$ $r_2 = 2.25\ cm$



$y_1 = y_2 = y$

$A_1 v_1 = A_2 v_2$ continuity eqn.

$$P_{g1} + \rho g y_1 + \frac{1}{2}\rho v_1^2 = P_{g2} + \rho g y_2 + \frac{1}{2}\rho v_2^2$$

$$P_1 - P_{atm} + \rho g y + \frac{1}{2}\rho v_1^2 = P_2 - P_{atm} + \rho g y + \frac{1}{2}\rho v_2^2$$

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

$$P_1 - P_2 = \frac{1}{2}\rho(v_2^2 - v_1^2) = \frac{1}{2}\rho\left(v_2^2 - \frac{A_2^2}{A_1^2}v_2^2\right)$$

Note $P_1 - P_2 = P_{g1} - P_{g2} = 33.5\times10^3 - 22.6\times10^3 = 10.9\times10^3\ Pa$

$$\therefore \frac{2}{\rho}(P_1 - P_2) = \left(1 - \frac{A_2^2}{A_1^2}\right)v_2^2$$

$$\Rightarrow v_2 = \sqrt{\frac{2(P_1 - P_2)}{\rho\left(1 - \frac{A_2^2}{A_1^2}\right)}} = \sqrt{\frac{2\times10.9\times10^3}{1000\left(1 - \left(\frac{2.25}{3}\right)^4\right)}} \simeq 5.6\ m/s$$

$\Rightarrow$ Volume flow rate $= A_1 v_1 = A_2 v_2 = \pi r_2^2 v_2 \simeq 0.009\ m^3/s$

$\simeq 9000\ cm^3/s = 9\ Liters/s$

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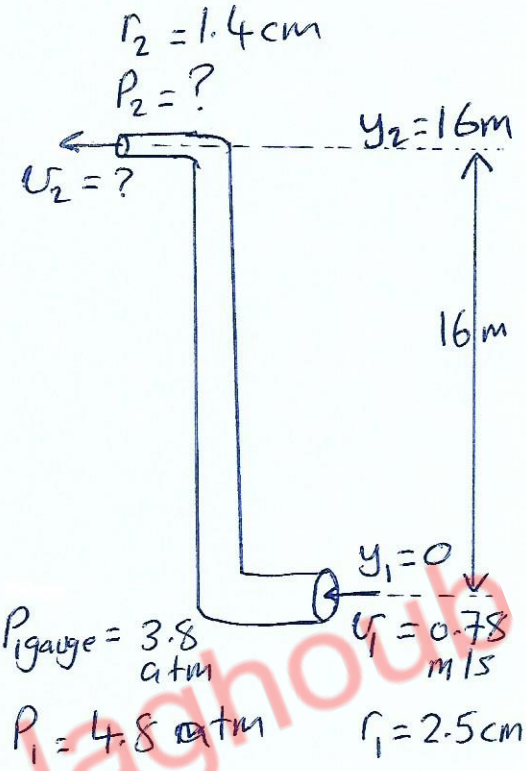
48]



Find v_2 from continuity equation.

$$A_1 v_1 = A_2 v_2$$

$$v_2 = \frac{A_1}{A_2} v_1$$

$$= \left(\frac{r_1}{r_2}\right)^2 v_1 = \left(\frac{2.5}{1.4}\right)^2 (0.78)$$

$$v_2 \simeq 2.5 \text{ m/s}$$

Now, apply Bernoulli's eqn to find P_{2gauge}.

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$$

$$\underbrace{P_1 - P_{atm}}_{P_{1g}} + \frac{1}{2}\rho v_1^2 + \rho g(y_1 - y_2) - \frac{1}{2}\rho v_2^2 = \underbrace{P_2 - P_{atm}}_{P_{2g}}$$

$$P_{1g} + \frac{1}{2}\rho(v_1^2 - v_2^2) + \rho g(-16) = P_{2g}$$

$$3.8 \times 1.013 \times 10^5 + \frac{1}{2}(1000)\left((0.78)^2 - (2.5)^2\right) - 16(1000)(9.8) = P_{2g}$$

$$384940 - 2820.8 - 156800 = P_{2g}$$

$$225319.2 = P_{2gauge}$$

$$P_{2gauge} = 2.253192 \times 10^5 \text{ Pa}.$$

$$= 2.22 \text{ atm}.$$

Prof. Mahmoud Jaghoub

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Giancoli, 7th edition/solutions to Extra Problems

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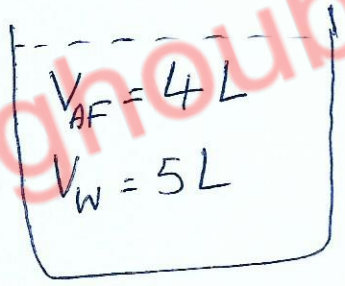
6] AF : antifreeze.
mix : mixture.



$$\rho_{mix} = \frac{m_{AF} + m_W}{V_{mix}} \quad (m_{mix})$$

$$= \frac{\rho_{AF} V_{AF} + \rho_W V_W}{V_{mix}}$$

$$SG_{mix} = \frac{\rho_{mix}}{\rho_W} = \frac{SG_{AF} V_{AF} + V_W}{V_{mix}} = \frac{(0.8)(4L) + 5L}{9L}$$

$$\therefore SG_{mix} = \frac{8.2\,L}{9\,L} = 0.91$$

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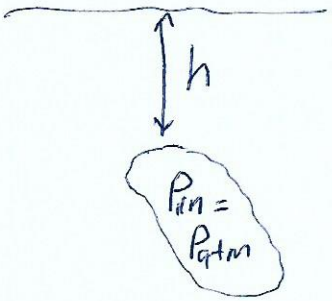
13]

Pressure inside lungs = $P_{in} = P_{atm}$

Pressure outside lungs = P_{out}



$$P_{out} = P_{atm} + \rho_w g h$$

$$\Delta P = P_{out} - P_{in} = P_{atm} + \rho_w g h - P_{atm}$$

$$\Delta P = \rho_w g h$$

$$\therefore h = \frac{\Delta P}{\rho_w g} = \frac{85\ mm\ Hg \times \frac{1.013 \times 10^5}{760\ mm\ Hg}}{1000 \times 9.8}$$

$$h = 1.156\ m \sim 1.16\ m.$$

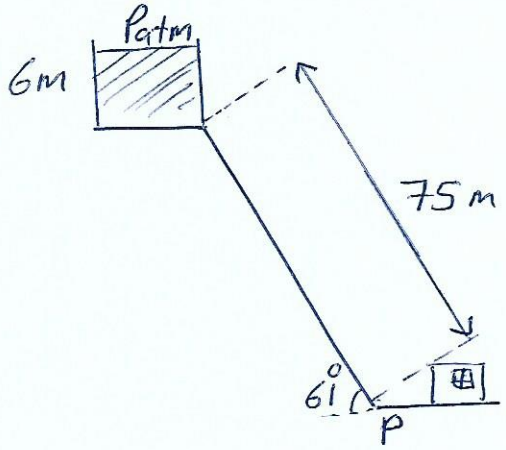
17]

(a) $P = P_{atm} + \rho g(6) + \rho g(75 \sin 61)$

$$P_{gauge} = P - P_{atm} = \rho g[6 + 75 \sin 61^\circ]$$

$$P_{gauge} = (1000)(9.8)[6 + 75 \sin 61]$$

$$P_{gauge} = 701645\ Pa.$$



(b) Ignoring friction forces the water <u>cannot</u> exceed the top of the tank by conservation of mechanical energy.

$$\therefore h_{max} = 75 \sin 61 + 6 \simeq 71.6\ m.$$

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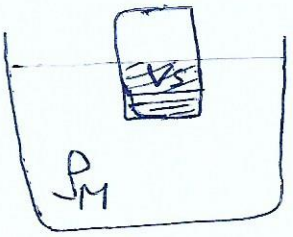
23] $\frac{\rho_o}{\rho_F} = \frac{V_s}{V}$



O: object (iron)
F: Fluid (Mercury)

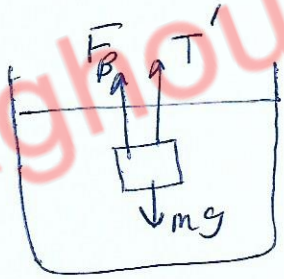
$\frac{V_s}{V} = \frac{7.8 \times 10^3}{13.6 \times 10^3} \simeq 0.57$

$\Rightarrow$ required fraction $\frac{V_s}{V} = 0.57$

i.e 57% of the volume will be below the surface of the mercury.

24] $F_B + T' = mg$

$F_B = mg - T' = \rho_w V g$



$\therefore V = \frac{mg - T'}{\rho_w g} = \frac{9.28g - 6.18g}{1000g}$

Note: T' is the apparent weight in water $= 6.18\,g$

V is the volume of the displaced fluid = volume of the mass as it is fully under water.

$V = 0.0031 \quad m^3$.

$\rho_{mass} = \frac{9.28\ kg}{0.0031\ m^3} = 2993.5\ kg/m^3$

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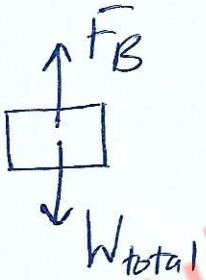
30] displaced volume $= 69.6\,L = 69.6 \times 10^{-3}\ m^3$

F_b = weight of displaced fluid

$F_b = \rho_w (69.6 \times 10^{-3}) g \simeq 682\ N$.

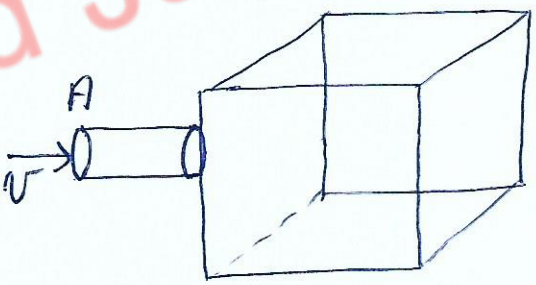
$W_{total} = m_{total} g = 72.8 g \simeq 713\ N$.



Since $W_{total} > F_B \Rightarrow$

diver will sink.

37] every 12 min a volume of air = 143.5 enters the room through the duct.



Volume of room
$= 8.2 \times 5 \times 3.5\ m^3$
$= 143.5\ m^3$

Volume flow rate $= \frac{\Delta V}{\Delta t}$

$\frac{\Delta V}{\Delta t} = A\upsilon$

$\frac{143.5\ m^3}{12 \times 60\ s} = 0.1993 \frac{m^3}{s} = A\upsilon$

$\therefore \upsilon = \frac{0.1993\ m^3/s}{\pi (0.12)^2\ m^2} \simeq 4.4\ m/s$

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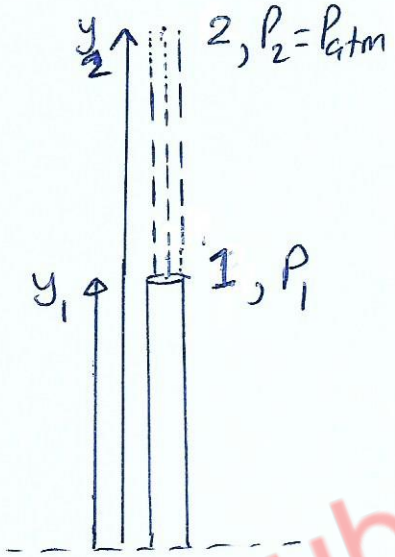
43] At points 1 and 2 the velocities v_1 and v_2 are zero. Pressure is needed for water to acquire velocity at point 1.



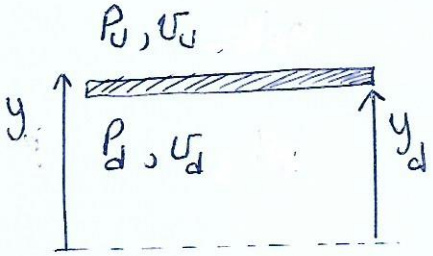
$$P_1 + \rho g y_1 + \frac{1}{2}\rho v_1^2 = P_2 + \rho g y_2 + \frac{1}{2}\rho v_2^2$$

$$P_1 + \rho g y_1 + 0 = P_{atm} + \rho g y_2 + 0$$

$$P_1 - P_{atm} = \rho g (y_2 - y_1)$$

$$= (1000)(9.8)(16) = 1.56 \times 10^5 \text{ Pa}.$$

44] Since $y_u \sim y_d \Rightarrow \rho g y_u = \rho g y_d$



Apply Bernoulli's eqn to upper and lower regions as shown:

$$P_u + \frac{1}{2}\rho v_u^2 + \rho g y_u = P_d + \frac{1}{2}\rho v_d + \rho g y_d$$

Assume air inside house to have zero speed $\Rightarrow v_d = 0$.

while $v_u = 180 \times \frac{1000}{3600} = 50$ m/s $\Rightarrow P_u < P_d$ and so a net lifting force is $(P_d - P_u)A$

Need to find $P_d - P_u$.

$\frac{1}{2}\rho(v_u^2 - v_d^2) = P_d - P_u \Rightarrow P_d - P_u = \frac{1}{2}(1.29)(50^2 - 0) = 1612.5$ Pa

just to lift the roof $Mg = (P_d - P_u)A = 1612.5 \times 6.2 \times 12.4$

$= 123969$ Newton.

$\Rightarrow$ weight of roof $Mg \approx 1.24 \times 10^5$ N.

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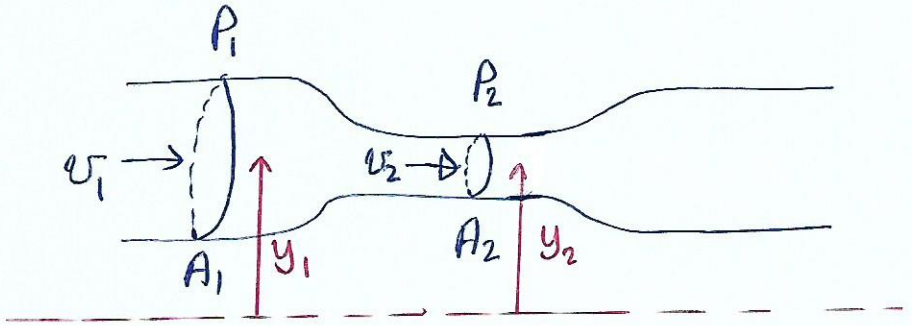
50] Venturi tube is used to measure the flow speed of liquids ands gases. L6



continuity equation $\Rightarrow A_1 v_1 = A_2 v_2$ — (1)

Bernoulli's equation:

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2 \quad -(2)$$

$y_1 = y_2 \Rightarrow \rho g y_1 = \rho g y_2$

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

[NOTE: $P_1 > P_2$ as $v_1 < v_2$]

from (1) $v_2 = \frac{A_1}{A_2} v_1$

substitute for v_2 in eq. (2) we get

$$P_1 - P_2 = \frac{1}{2}\rho \left(\frac{A_1^2}{A_2^2} - 1\right) v_1^2 = \frac{1}{2}\rho \times \frac{1}{A_2^2}(A_1^2 - A_2^2) v_1^2$$

$$\therefore 2A_2^2 (P_1 - P_2) = \rho (A_1^2 - A_2^2) v_1^2$$

$$\Rightarrow v_1 = A_2 \sqrt{\frac{2(P_1 - P_2)}{\rho (A_1^2 - A_2^2)}}$$

so, if we know A_1, A_2, P_1 and P_2 we can determine the flow speed v_1.

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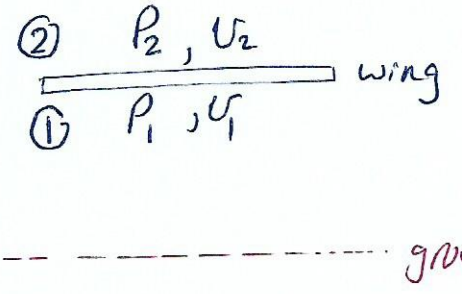
47] assume the heights of bottom and top surfaces of the wing to be the same.



$\Rightarrow \rho g y_1 = \rho g y_2$

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g y_2$$

$v_2 = 280\ m/s > v_1 = 150\ m/s$

$\Rightarrow P_2 < P_1$

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

$$= \frac{1}{2}(1.29)((280)^2 - (150)^2) = 36055.5\ Pa$$

lifting force $= (P_1 - P_2)A = (P_1 - P_2)(88)$

(A: wing's area)

$\therefore$ lifting force $F_L = (36055.5)(88)$

$\approx 3.173 \times 10^6\ N.$

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Additional Problem

A collapsible plastic bag contains glucose solution. If the average gauge pressure in the vein is 1.33 kPa, what must be the minimum height h of the bag in order to infuse glucose into the vein?

Assume $SG_{glucose} = 1.02$

$\Rightarrow \rho_{glucose} = 1.02 \times \rho_w = 1020\ kg/m^3$.

$$P_{glucose} = P_{atm} + \rho_{glucose} g h$$

$$\underbrace{P_{glucose} - P_{atm}}_{P^{glucose}_{gauge}} = \rho_{glucose} g h$$

$$P^{glucose}_{gauge} = \rho_{glucose} g h$$

for glucose to be infused into the vein $\Rightarrow$

$$P^{glucose}_{gauge} \geq P^{blood}_{gauge}$$

$$\rho_{glucose} g h \geq 1.33 \times 10^3$$

$$\therefore h = \frac{1.33 \times 10^3}{1020 \times 9.8} \sim 0.133\ m.$$

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