chapter 14

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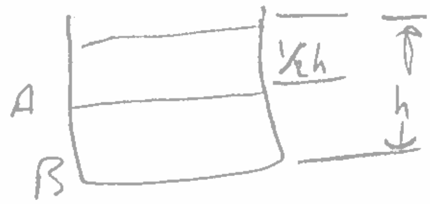
(1) $P_A = \frac{2}{3} P_B$



$P_0 + \rho g \frac{1}{2} h = \frac{2}{3}(P_0 + \rho g h)$

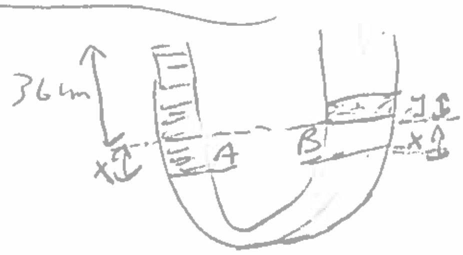
$P_0 + \rho g \frac{h}{2} = \frac{2}{3} P_0 + \rho g \frac{2}{3} h$

$\frac{1}{3} P_0 = \rho g h \frac{1}{6}$

$2 P_0 = \rho g h$

$\therefore h = \frac{2 P_0}{\rho g} = \boxed{20 m}$

(2) $P_A = P_B$



$\cancel{P_0} + \rho g h)_w = \cancel{P_0} + \rho \cancel{g} h)_{Hg}$

$\rho_w h_w = \rho_{Hg} h_{Hg}$

$\rho_w (36 + X) = \rho_{Hg} (y + X)$ (1)

$V_A = V_B \qquad A_x = \frac{1}{4} A_y$

$X A_x = y A_y$

$X \frac{1}{4} \cancel{A_y} = y \cancel{A_y}$

$\boxed{X = 4y}$ (2)

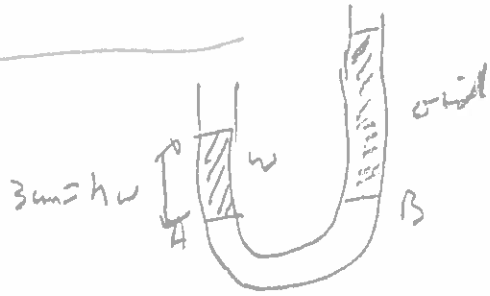
(2) in (1) $\Rightarrow$

$\rho_w (36) + \rho_w (4y) = \rho_{Hg} (y + 4y)$

$36 \rho_w = y (5 \rho_{Hg} - 4 \rho_w)$

$y = \frac{36(1)}{5(13.6) - 4} = 0.56 \text{ cm}$

(3) $P_A = P_B$



$\cancel{P_0} + \rho g h)_w = \cancel{P_0} + \rho \cancel{g} h)_{oil}$

$\rho_w (3) = \rho_{oil} (h_{oil})$

$\therefore h_{oil} = \frac{(3)(1)}{0.75} = 4 \text{ cm}$

④ $\rho_{oil} = 750\ kg/m^3$

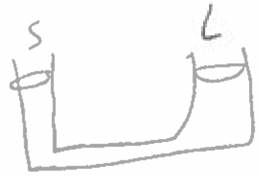
$P = P_w + P_{oil}$

$= \rho g h)_w + \rho g h)_{oil}$

$= g\{(1000)(0.25) + (750)(0.12)\}$

$= 3.33\ kPa$

⑤ $d_s = 2cm$ $\quad P_s = P_L$



$d_L = 8cm$ $\quad \cancel{P_a} + \frac{F}{A})_s = \cancel{P_a} + \frac{F}{A})_L$

$F_s = ?$ $\quad \frac{F_s}{\pi(2\times10^{-2})^2} = \frac{1600}{\pi(8\times10^{-2})^2}$

$F_L = 1600N$

$\Rightarrow F_s = 1600 \frac{2^2}{8^2} = \boxed{100W}$

⑥ $F_b = W - W_a = 10 - 6N = 4N$

$F_b = W_{RF} = g m_{RF} = g \rho_w \frac{4}{3}\pi R^3 = 4$ $\quad \rho = \frac{m}{v}$

$\boxed{\therefore R = 4.6\ cm}$

⑦ $B = T + mg$ $\quad V = 0.1\ m^3$

$W_{RF} = T + mg$ $\quad T = ?$

$g\, m_{RF} = T + mg$ $\quad \rho = \frac{m}{v}$

$g \rho_w V_o = T + 10g$

$g(1000)(0.1) - 10g = T$

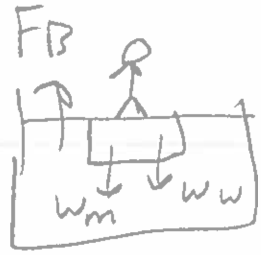
$\boxed{\therefore T = 882N}$

(8) $\rho_w = 850\ kg/m^3$

$w_m = 50\ kg$

$V_w = ??$ (min)

$\rho = \frac{m}{v}$



$F_B = w_m + w_{wood}$

$w_{RF} = 250 + g\, m_{wood}$

$\cancel{g}\, \rho_w V_{wood} = \cancel{g} 50 + \cancel{g}\, \rho_{wood} V_{wood}$

$1000 V_{wood} - 850 V_{wood} = 50$

$150 V_{wood} = \frac{50}{(150)} = 0.33\ m^3$

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(9) In water!!

$F_B = mg)_w$

$\rho_w g V_{wsub} = mg$

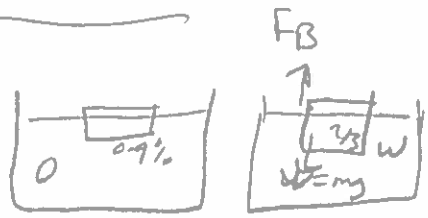
$\rho_w g \frac{2}{3} V = mg$ (1)

in oil

$F_B = mg)_{oil}$

$\rho_{oil} g V_{wsub} = mg$

$\rho_o g (0.9) V = mg$ (2)



(1)=(2) $\Rightarrow$ $\rho_w \cancel{g} (\frac{2}{3}) \cancel{V} = \rho_o \cancel{g} (0.9) \cancel{V}$ $\Rightarrow$ $\rho_o = 1000 \times \frac{2}{3} \times (\frac{1}{0.9})$

$\rho_o = 740\ kg/m^3$

(1) $\Rightarrow$ $\rho_w \cancel{g} \frac{2}{3} V_{block} = \rho_{block} V_{block} \cancel{g}$

$(1000) \frac{2}{3} \cancel{V_b} = \rho_{block} \cancel{V_b}$

$\therefore \boxed{\rho_{block} = 670\ kg/m^3}$

(10) $F_B = W_M + W_{ice}$

$\cancel{g} m_{RF} = 100\cancel{g} + \cancel{g}\rho_i V_{ice}$

$\rho = \frac{m}{v}$

$\rho_w V_i = 100 + \rho_i V_i$

$1000 V_i - 917 V_i = 100$

$V_i = \frac{100}{83} = 1.205\ m^3$

$V_i = Ah \Rightarrow A = \frac{V}{h} = \frac{1.205}{0.5} = \boxed{2.41\ m^2}$

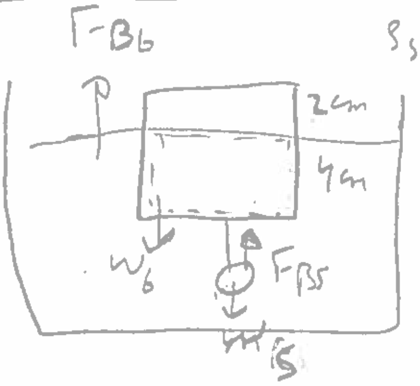
(11)

$\rho_w = 0.98 g/L$

$\rho_s = 7.79 g/cm^3$

$F_{Bb} + F_{Bs} = W_s + W_b$

$h = 6\ cm$
$A_b = 12\ cm^2$
$\rho_b = 0.3\ g/cm^3$
$h_s = d_b = 4\ cm$
$R_b = ?$



$W_{sw(b)} + W_{sw(s)} = g m_s + g m_b$

$\cancel{g}\rho_w (4 \times 12) + \cancel{g}\rho_w \boxed{V_s} = \cancel{g}\rho_s \boxed{V_s} + \cancel{g}(6 \times 12)$

$V_s = 3.8\ cm^3 \Rightarrow V_s = \frac{4}{3}\pi R^3 \Rightarrow \boxed{R = 9.7\ cm}$

(12)

a) $d_2 = 5\ cm \Rightarrow A_2 = \pi R^2 = \pi\left(\frac{5}{100}\right)^2$

$d_1 = 3\ cm \qquad A_1 = \pi\left(\frac{3}{100}\right)^2$

$u_2 = ?$

$u_1 = 15\ m/s \qquad$ Continuity eq.

$A_1 u_1 = A_2 u_2$

$\cancel{\pi}\left(\frac{5}{100}\right)^2 u_2 = (15)\left(\frac{3}{100}\right)^2 \cancel{\pi}$

$25 u_2 = 15(9) \Rightarrow \boxed{u_2 = 5.4\ m/s}$

b) $V = (\overset{x}{u_1 t}) A = 15(10 \times 60)\left(\left(\frac{0.03}{2}\right)^2\pi\right) \qquad u = \frac{x}{t}$

$\boxed{= 6.4\ m^3}$

(13) in + $\Rightarrow$ net flow rate $= 0$
out $-$ $\Rightarrow +2+10+1 = X+8+4$
$\therefore X = -1$ (out)

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(14)

mass flow rate $= \rho R_v = \rho A u$

$= (1000)(5)(0.01)^2 \pi = 1.57$ kg/s

mass $= 1.57 \times t = 1.57 \times 60 = \boxed{94 \text{ kg}}$

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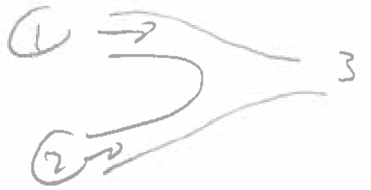
(15) $A_1 u_1 + A_2 u_2 = A_3 u_3$



$8 \times 4 \times 2 + 7 \times 3 \times 4 = 10 \times 4 \times h$

$\boxed{h = 3.7 \text{ m}}$

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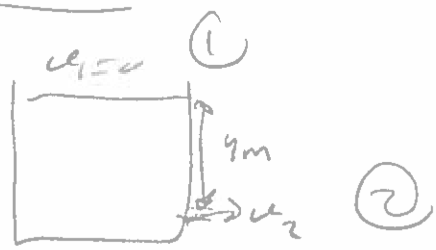
(16) $P_1 + \frac{1}{2}\rho u_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho u_2^2 + \rho g h_2$



$4g = \frac{1}{2} u_2^2 + 0$

$u_2 = \sqrt{8g} = 8.85$ m/s

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(17)

$\Delta y = 0$

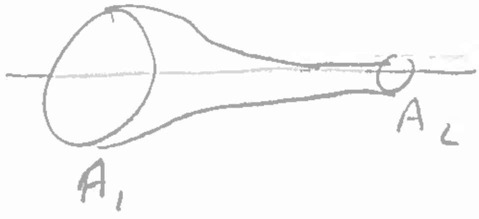
Continuity eq:

$A_1 u_1 = A_2 u_2$

$10 u_1 = 5 u_2$

$\boxed{\therefore 5 u_1 = u_2}$

$A_1 = 10 \text{ cm}^2$
$A_2 = 5 \text{ cm}^2$
$\Delta p = 300$ Pa
$u_1 = ?$



Bernoulli eq.

$P_1 + \frac{1}{2}\rho u_1^2 = P_2 + \frac{1}{2} u_2^2$

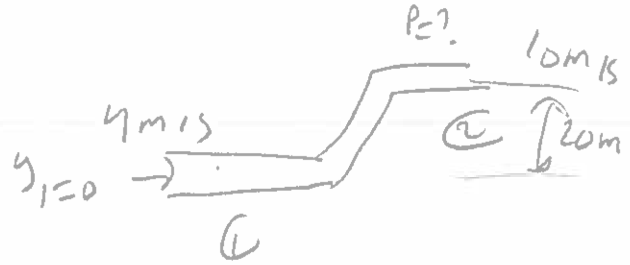
$P_1 - P_2 = \frac{1}{2}\rho (u_2^2 - u_1^2)$

$300 = \frac{1}{2}(1000)(25 u_1^2 - u_1^2)$

$\Rightarrow \boxed{u_1 = 0.447 \text{ m/s}}$

(18) $P_1 = 65\ kPa$

$P_2 = ?$



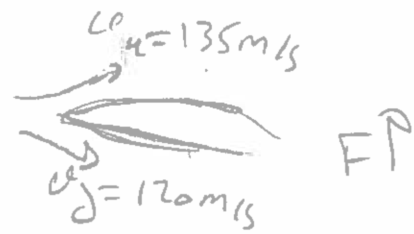
$$P_1 + \frac{1}{2}\rho u_1^2 + \rho g y_1 = P_2 + \frac{1}{2}\rho u_2^2 + \rho g y_2$$

$$65000 + \frac{1}{2}(10^3)(16) + 0 = P_2 + \frac{1}{2}(10^3)(100) + (10^3)(g)(20)$$

$$\boxed{P_2 = 3.4\ kPa}$$

(19) $A = 28\ m^2$

$F = ?$



$$P_u + \frac{1}{2}\rho u_u^2 = P_d + \frac{1}{2}\rho u_d^2$$

$$\frac{1}{2}\rho(u_u^2 - u_d^2) = P_d - P_u \quad (1)$$

$$(1) \times A \Rightarrow F = A\frac{1}{2}\rho(u_2^2 - u_1^2)$$

$\Delta P = \frac{F}{A}$

$\therefore F_p = \Delta P A$

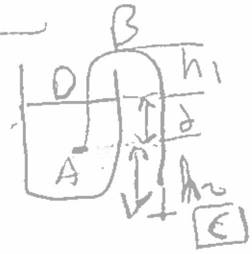
$= (P_d - P_u)A \quad (2)$

$$\therefore F_p = \frac{1}{2}\rho(u_u^2 - u_d^2)A$$

$$= \frac{1}{2}(1.2)(135^2 - 120^2) = (19)(28)$$

$$F_p = 64.3\ kN$$

(20) a) use Bernoulli eq of D and C



$$\left(P + \frac{1}{2}\rho u^2 + \rho g h\right)_D = \left(P + \frac{1}{2}\rho u^2 + \rho g h\right)_C$$

$$2(g h_D - g h_C) = u_C^2$$

$$\therefore u_C = \sqrt{2g(h_D - h_C)} = \boxed{\sqrt{(2)(g)(d + h_2)} = 3.2\ m/s}$$

(b) Consider points B and C:

$$P_B + \tfrac{1}{2}\cancel{\rho u_B^2} + \rho g h_B = P_C + \tfrac{1}{2}\cancel{\rho u_C^2} + \rho g h_C$$

$u_B = u_C$

$$P_B = P_C + \rho g (h_C - h_B)$$

$$= P_a + (10^3)(9.8)[-(h_1 + l + h_2)]$$

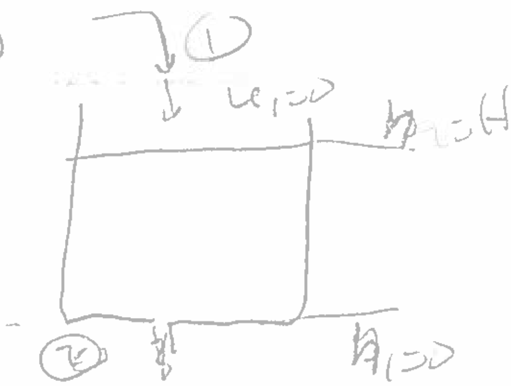
$$= 10^5 - 9800[0.25 + 0.4 + 0.12]$$

$$\boxed{P_B = 9.2 \times 10^4 \text{ Pa}}$$

$h_C > h_B$

$h_C - h_B = -$

(21) Using Bernoulli eq points (1) and (2) ⇒



$$\cancel{P_1} + \tfrac{1}{2}\cancel{\rho u_1^2} + \rho g h_1 = \cancel{P_2} + \tfrac{1}{2}\rho u_2^2 + \cancel{\rho g h_2}$$

$$\rho g h_1 = \tfrac{1}{2}\rho u_2^2$$

$$\boxed{\therefore u_2 = \sqrt{2gH}}$$

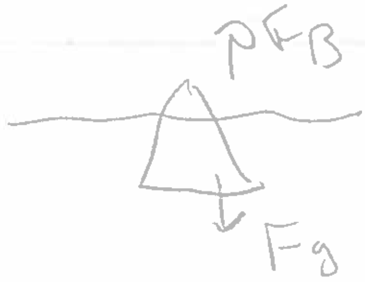
$$u_1 A_1 = u_2 A_2 = R_V = Q$$

$$\boxed{\therefore A_2 = \frac{Q}{u_2} = \frac{Q}{\sqrt{2gH}}}$$

iceberg:-

$\rho_{ice} = 917 kg/m^3$

$\rho_{\substack{sea \\ w}} = 1024 kg/m^3$



$$\frac{V_{sub}}{V_{tot}} = \frac{\rho_{ice}}{\rho_w} = \frac{917}{1024} =$$

$$\frac{V_{visible}}{V_{tot}} = 1 - \frac{917}{1024} = 0.1 = 10\%$$

$$F_B = F_G \Rightarrow m_{\cancel{g}F}\,\cancel{g} = M\,\cancel{g} \qquad \rho = \frac{m}{v}$$

$$\rho_W\, m_{sub} = \rho_{ice}\, V_{tot}$$

$$\boxed{\frac{\rho_{ice}}{\rho_w} = \frac{m_{sub}}{m_{tot}}}$$