PH212 - Chapter 13 Homework Solutions

10) $P = \frac{F}{A}$ $\quad F = PA = mg \quad m = \frac{PA}{g}$

$$m = \frac{(240\times10^3)(4)(200)(10^{-2})^2}{(9.8)} = 1960\text{ kg}$$

11) $F = PA = mg \quad m = \frac{PA}{g} = \frac{P(\pi R^2)}{g} = \frac{P(\pi D^2/4)}{g}$

$$m = \frac{P\pi D^2}{4g} = \frac{(17.0)(1.013\times10^5)(\pi)(0.245)^2}{(4)(9.8)} = 8280\text{ kg}$$

14) $P = \rho g h \quad h = \frac{P}{\rho g} = \frac{1.013\times10^5}{(1.29)(9.8)} = 8010\text{ m} = 8.01\text{ km}$

17) $P = P_0 e^{-(\rho_0 g/P_0)y} = (1.013\times10^5)\cdot e^{-(1.29)(9.8)(8850)/(1.013\times10^5)}$

$P = 33{,}600\text{ Pa}$

18) $P = \rho g h = (1000)(9.8)(36.5) = 358{,}000\text{ Pa} = 3.58\times10^5\text{ Pa}$

23) (a) $F = \int dF = \int P\,dA = \int P b\,dy = \int_0^h \rho g y b\,dy = \rho g b \int_0^h y\,dy$

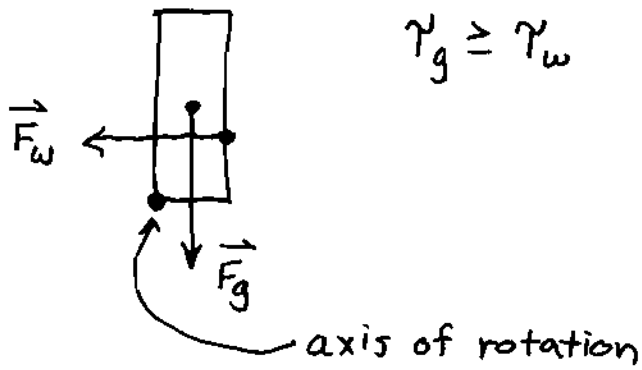
$$F = \rho g b\left[\tfrac{1}{2}y^2\right]_0^h = \rho g b\left(\tfrac{1}{2}h^2 - 0\right) = \tfrac{1}{2}\rho g h^2 b. \checkmark$$

(b) $\tau = \int d\tau = \int R\,dF = \int_0^h (h-y)\rho g y b\,dy = \rho g b \int_0^h y(h-y)\,dy$

$$\tau = \rho g b \int_0^h (hy - y^2)\,dy = \rho g b\left[\tfrac{1}{2}hy^2 - \tfrac{1}{3}y^3\right]_0^h$$

$$\tau = \rho g b\left[\left(\tfrac{1}{2}h^3 - \tfrac{1}{3}h^3\right) - (0-0)\right] = \tfrac{1}{6}\rho g h^3 b = \tfrac{1}{3}hF. \checkmark$$

23) (c) $\rho_\omega = 1000\ kg/m^3$ $\rho_c = 2300\ kg/m^3$



$\tau_g \geq \tau_\omega$

$\tau_g = R_\perp F_g = \frac{t}{2} F_g$

$\tau_\omega = R_\perp F_\omega = \frac{h}{3} F_\omega$

$$\frac{t}{2} F_g \geq \frac{h}{3} F_\omega \qquad t \geq \frac{2hF_\omega}{3F_g} = \frac{2h\left(\frac{1}{2}\rho_\omega g h^2 b\right)}{3mg}$$

$$t \geq \frac{h^3 \rho_\omega g b}{3mg} = \frac{h^3 \rho_\omega g b}{3\rho_c V_c g} = \frac{h^3 \rho_\omega b}{3\rho_c h b t} = \frac{h^2 \rho_\omega}{3\rho_c t}$$

$$t^2 \geq h^2\left(\frac{\rho_\omega}{3\rho_c}\right) \qquad t \geq h\sqrt{\frac{\rho_\omega}{3\rho_c}} = h\left(\frac{(1000)}{(3)(2300)}\right)^{1/2}$$

$$t \geq 0.381 h$$

Atmospheric pressure does not need to be added because it pushes equally on all sides of the dam.

27) $$\frac{\rho_R}{\rho_\omega} = \frac{F_g}{F_g - F_g'} = \frac{mg}{mg - m'g} = \frac{m}{m - m'}$$

$$\rho_R = \frac{\rho_\omega m}{m - m'} = \frac{(1000)(7.85)}{(7.85 - 6.18)} = 4700\ kg/m^3$$

33) (a) F_B = weight of fluid displaced = F_g (fluid displaced)

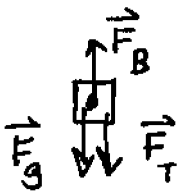
$F_B = \rho(\text{fluid})V(\text{displaced})g = \rho(\text{sea water})\frac{4}{3}\pi R^3 g$

$F_B = \rho(\text{sea water})\frac{4}{3}\pi\left(\frac{D}{2}\right)^3 g = \rho\frac{4}{3}\pi\frac{D^3}{8}g$

$F_B = \dfrac{\rho\pi D^3 g}{6} = \dfrac{(1025)(\pi)(6)^3(9.8)}{6} = 1140000\,N$

$F_B = 1.14\times10^6\,N$

(b)



$\Sigma\vec{F} = (+F_B) + (-F_g) + (-F_T) = 0$

$F_T = F_B - F_g = F_B - mg$

$F_T = (1.14\times10^6) - (75{,}000)(9.8) = 4.05\times10^5\,N$

34) (a) $F_B = \rho(\text{sea water})V(\text{displaced})g = (1025)(65\times10^{-3})(9.8)$

$F_B = 653\,N$

(b) $F_g = mg = (63)(9.8) = 617\,N$

The diver will float since $F_B > F_g$.

43) $\dfrac{\Delta V}{\Delta t} = Av \qquad v = \dfrac{\Delta V}{A\Delta t} = \dfrac{(9.2)(5)(4.5)}{(\pi)(0.15)^2(12\times60)} = 4.07\,m/sec$

48) $\frac{1}{2}\rho v_1^2 + P_1 = \frac{1}{2}\rho v_2^2 + P_2 \qquad A_1v_1 = A_2v_2 \qquad v_1 = \dfrac{A_2v_2}{A_1}$

$\frac{1}{2}\rho\left(\frac{A_2v_2}{A_1}\right)^2 + P_1 = \frac{1}{2}\rho v_2^2 + P_2 \qquad v_2^2\left(\frac{1}{2}\rho\left(\left(\frac{A_2}{A_1}\right)^2 - 1\right)\right) = P_2 - P_1$

$v_2 = \left(\dfrac{P_2 - P_1}{\rho/2\left[(A_2/A_1)^2 - 1\right]}\right)^{1/2} = \left(\dfrac{32000 - 24000}{(1000/2)\left[(\pi(\frac{6}{2})^2/\pi(\frac{4}{2})^2)^2 - 1\right]}\right)^{1/2} = 1.98\,m/s.$

$A_2v_2 = (\pi)(0.06/2)^2(1.98) = 5.61\times10^{-3}\,m^3/sec.$

51) $\frac{1}{2}\rho v_1^2 + P_1 = \frac{1}{2}\rho v_2^2 + P_2 \qquad F(\text{lift}) = (P_2 - P_1)A$

$$F(\text{lift}) = \left(\frac{1}{2}\rho v_1^2 - \frac{1}{2}\rho v_2^2\right)A = \frac{\rho A}{2}(v_1^2 - v_2^2)$$

$$F(\text{lift}) = \frac{(1.29)(86)}{2}(340^2 - 290^2) = 1750000\ N = 1.75\times10^6\ N$$

54) $A_1 v_1 = A_2 v_2 \qquad v_2 = \frac{A_1 v_1}{A_2} = \frac{(\pi D_1^2/4)v_1}{(\pi D_2^2/4)} = \frac{D_1^2 v_1}{D_2^2}$

$$v_2 = \frac{(5)^2(0.6)}{(2.6)^2} = 2.22\ m/sec$$

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

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

$$P_2 = (3.8)(1.013\times10^5) - (1000)(9.8)(20) + \frac{1}{2}(1000)(0.6^2 - 2.22^2)$$

$$P_2 = (384{,}940) + (196{,}000) + (-2284.2)$$

$$P_2 = 187000\ Pa = 1.87\times10^5\ Pa$$

59) (a) $\vec{x} = \vec{x}_0 + \vec{v}_{0x}t + \frac{1}{2}\vec{a}_x t^2 \qquad \vec{y} = \vec{y}_0 + \vec{v}_{0y}t + \frac{1}{2}\vec{a}_y t^2$

$\vec{x} = v_1 t \qquad 0 = h_1 + 0 - \frac{1}{2}gt^2$

$\vec{x} = v_1\sqrt{\frac{2h_1}{g}} \qquad t = \sqrt{\frac{2h_1}{g}}$

From problem 55, assuming $A_1 << A_2$, $v_1 = \sqrt{2g(h_2 - h_1)}$

$$\vec{x} = \sqrt{2g(h_2 - h_1)}\sqrt{\frac{2h_1}{g}} = 2\sqrt{h_1(h_2 - h_1)}$$

59) (b) $\vec{x}' = \vec{x}$ $\qquad 2\sqrt{h_1'(h_2-h_1')} = 2\sqrt{h_1(h_2-h_1)}$

$$h_1'(h_2-h_1') = h_1(h_2-h_1)$$

$$-h_1'^2 + h_1'h_2 - h_1h_2 + h_1^2 = 0$$

$$(h_1')^2 - h_2(h_1') + (h_1h_2 - h_1^2) = 0$$

$$h_1' = \frac{-(-h_2) \pm \sqrt{(-h_2)^2 - (4)(1)(h_1h_2 - h_1^2)}}{(2)(1)}$$

$$h_1' = \frac{h_2 \pm \sqrt{h_2^2 - 4h_2h_1 + 4h_1^2}}{2} = \frac{h_2 \pm \sqrt{(h_2 - 2h_1)^2}}{2}$$

$$h_1' = \frac{h_2 \pm (h_2 - 2h_1)}{2} = \frac{2h_2 - 2h_1}{2} \text{ or } \frac{2h_1}{2}$$

$h_1' = h_2 - h_1$ or h_1 $\qquad h_1' = h_2 - h_1$.

85) $P = \frac{F}{A} = \frac{mg}{4\pi R_e^2}$ $\qquad m = \frac{4\pi R_e^2 P}{g}$

$$m = \frac{4\pi(6.38\times10^6)^2(1.013\times10^5)}{(9.8)} = 5.29\times10^{18}\text{ kg}$$