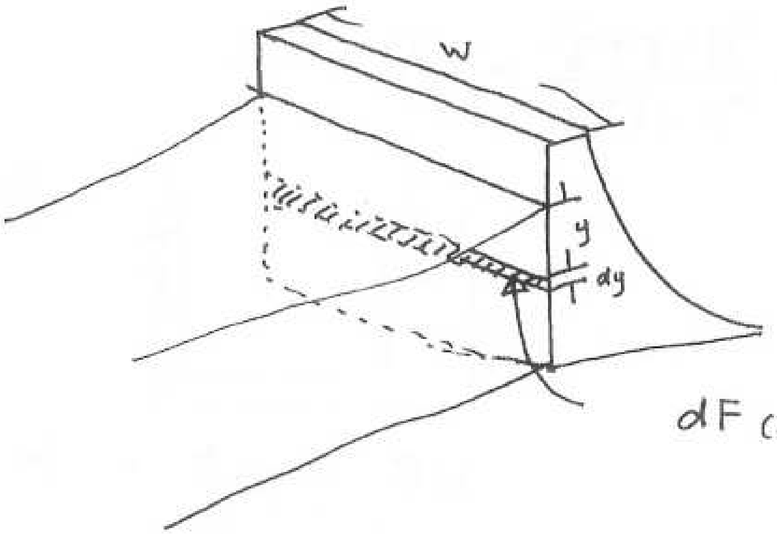
ch. 14 #19, 22, 31, 37, 59, 61

19



dF (at shaded area) $= P_r \cdot dA$

$= \rho g y \cdot w \cdot dy$

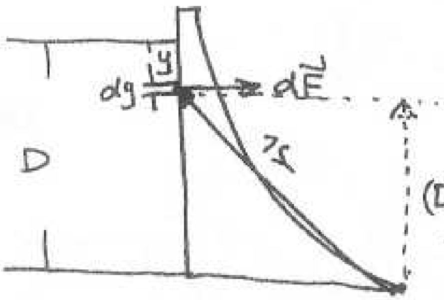
$= \rho g w \cdot y \cdot dy$

(a) $F = \int dF = \int_0^D \rho g w \cdot y \cdot dy$

$= \rho g w \cdot \frac{1}{2} y^2 \Big|_0^D$

$= \underline{\underline{\frac{1}{2} \rho g w D^2}}$

(b)



$d\tau = \vec{r} \times d\vec{F} = (D-y) P_r \cdot dA$

$= (D-y)(\rho g y) \cdot w \cdot dy$

This is the perpendicular distance to $d\vec{F}$

$= \rho g w (Dy - y^2) dy$

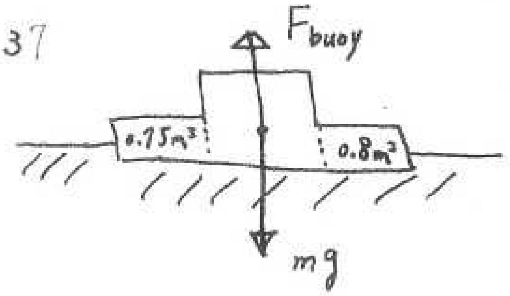
$\therefore \quad \tau = \int d\tau = \int_0^D \rho g w (Dy - y^2) dy$

$= \rho g w \left(\frac{1}{2} D y^2 - \frac{1}{3} y^3\right)\Big|_0^D$

$= \rho g w \left(\frac{1}{2} D^3 - \frac{1}{3} D^3\right)$

$= \underline{\underline{\frac{1}{6} \rho g w D^3}}$

#37



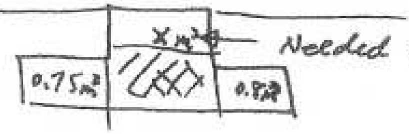
(a)

$$F_{buoy} - mg = 0$$

$$\rho_{H_2O} \cdot V_{H_2O \text{ displaced by the car}} \cdot g - mg = 0$$

$$V_{H_2O} = \frac{m}{\rho_{H_2O}} = \frac{1800\ kg}{1.0 \times 10^3\ kg/m^3} = \underline{\underline{1.8\ m^3}}$$

(b)

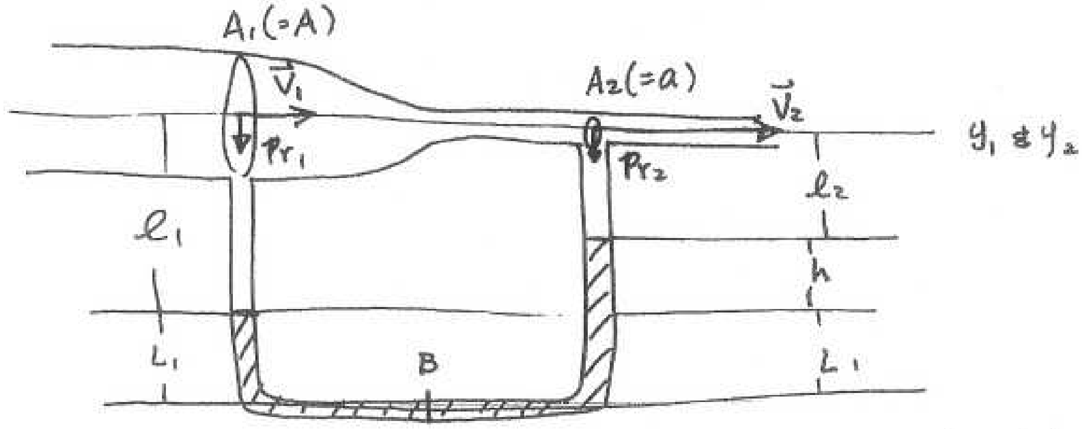


Needed vol. to displace water to be still floating.

$$1.8\ m^3 - (0.75 - 0.8)\ m^3 = 0.25\ m^3$$

So, $5\ m^3 - 0.25\ m^3 = \underline{\underline{4.75\ m^3}}$ is the H_2O vol. in the car.

#59



$$Pr_1 + \rho g y_1 + \frac{1}{2}\rho V_1^2 = Pr_2 + \rho g y_2 + \frac{1}{2}\rho V_2^2 \quad (y_1 = y_2)$$

$$\frac{1}{2}\rho (V_1^2 - V_2^2) = Pr_2 - Pr_1$$

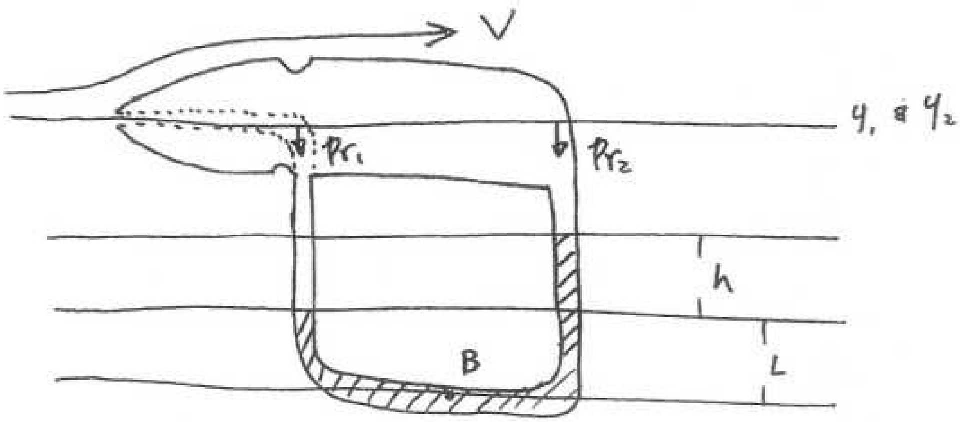
$$\left[\text{Also } A_1 V_1 = A_2 V_2 \qquad V_2 = \frac{A_1}{A_2} V_1 \right]$$

$$\frac{1}{2}\rho \left(V_1^2 - \frac{A_1^2}{A_2^2} V_1^2\right) = Pr_2 - Pr_1$$

$$\frac{1}{2}\rho V_1^2 \left(\frac{A_2^2 - A_1^2}{A_2^2}\right) = Pr_2 - Pr_1$$

$$\therefore V_1 = \sqrt{\frac{2 A_2^2 (Pr_2 - Pr_1)}{(A_2^2 - A_1^2)\rho}} \left(= \sqrt{\frac{2a^2 \Delta Pr}{\rho (a^2 - A^2)}} \right)$$

#61



$$Pr_1 + \rho_{air} g y_1 + \frac{1}{2}\rho_{air} V_1^2 = Pr_2 + \rho_{air} g y_2 + \frac{1}{2}\rho_{air} V_2^2 \quad (y_1 = y_2)$$

$$Pr_1 + \frac{1}{2}\rho_{air} \cancel{V_1^2}^{\,0} = Pr_2 + \frac{1}{2}\rho_{air} V_2^2 \quad \begin{pmatrix} V_1 = 0 \text{ in the tube} \\ V_2 = V \text{ air speed} \end{pmatrix}$$

$$V_2 = \sqrt{\frac{2(Pr_1 - Pr_2)}{\rho_{air}}} \quad \text{——— ①}$$

At B.

$$Pr\,(\text{Left side}) = Pr\,(\text{Right side})$$

$$Pr_1 + \rho' g L = Pr_2 + \rho' g (h+L)$$

$$Pr_1 - Pr_2 = \rho' g (h+L) - \rho' g L = \rho' g h \quad \text{— ②}$$

① ← ②

$$V_2 = V_{\text{air speed}} = \sqrt{\frac{2\rho' g h}{\rho_{air}}}$$