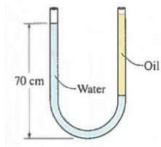


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1. Consider a U tube whose arms are open to the atmosphere. Water is poured into the U tube from one arm. After the water is let it sit, the surface level in both arms is at 50 cm. Now light oil ($\rho = 790 \text{ kg/m}^3$) is poured from the other arm. One arm now contains 70-cm-high water, while the other contains both fluids (see figure). Determine the height of each fluid in that arm.



$$\rho_w : 1000 \text{ kg/m}^3$$

$$\rho_o : 790 \text{ kg/m}^3$$

Total height of water column in left arm $h_w : 70 \text{ cm} = 0.7 \text{ m}$

initial height of water : 50 cm

$$50 \text{ cm} + 50 \text{ cm} = 100 \text{ cm}$$

$$h_{w \text{ right arm}} = (100 \text{ cm} - 70 \text{ cm}) = 30 \text{ cm}$$

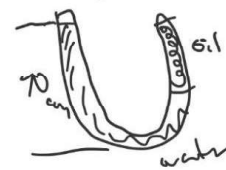
$$70 - 50 = 20 \text{ cm (left arm)}$$

$$50 - 20 = 30 \text{ cm (right arm)}$$

1st



2nd



$$P_{\text{left}} = P_{\text{right}}$$

$$70 \text{ cm} - 30 \text{ cm} = 40 \text{ cm} = 0.4 \text{ m}$$

$$P_{\text{left}} = P_{\text{atm}} + \rho_w \cdot g \cdot (h_w - h_{w, \text{right}})$$

$$P_{\text{right}} = P_{\text{atm}} + \rho_o \cdot g \cdot h_o$$

$$\rho_w \cdot (h_w - h_{w, \text{right}}) = \rho_o \cdot h_o$$

$$1000 \cdot (70 - 30) = 790 \cdot h_o$$

$$h_o = \frac{40000}{790} = 50.67 \text{ cm}$$

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$$a) \quad h_c = 15 \text{ ft} - 1 \text{ ft} = 14 \text{ ft}$$

$$F_H = \rho \cdot h_c \cdot A$$

$$= 62.4 (16 \text{ lb/ft}^3) \cdot 14 \text{ ft} \cdot (2 \text{ ft})^2 = 1797.216 \text{ lb}$$

$$A = 13 \text{ ft} \cdot 2 \text{ ft} + \frac{\pi (2 \text{ ft})^2}{4} = 29.1416 \text{ ft}^2$$

$$A_{\text{total}} = A_{\text{rectangle}} + A_{\text{cylinder}}$$

$$= 13 \text{ ft} \cdot 2 \text{ ft} + \frac{\pi (2 \text{ ft})^2}{4}$$

$$= 29.1416 \text{ ft}^2$$

$$F_v = \rho \cdot A \cdot L = 62.4 (16 \text{ lb/ft}^3) \cdot 29.1416 \text{ ft}^2 \cdot 1 \text{ ft}$$

$$= 1818.4416 \text{ lb}$$

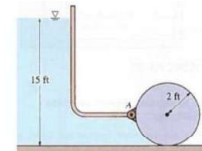
$$F_R = \sqrt{F_H^2 + F_v^2}$$

$$= \sqrt{(1797.2)^2 + (1818.44)^2}$$

$$= 2521.6816 \text{ lb}$$

$$\theta = \tan^{-1} \left(\frac{F_v}{F_H} \right) = \tan^{-1} \left(\frac{1818.44}{1797.2} \right) = 46.15^\circ$$

2. A long, solid cylinder of radius 2 ft hinged at point A is used as an automatic gate, as shown in the figure. When the water reaches 15 ft, the cylindrical gate opens by turning about the hinge at point A. Determine (a) the hydrostatic force acting on the cylinder and its line of action when the gate opens, and (b) the weight of the cylinder per ft length of the cylinder.



$$b) \quad \Delta_y = \frac{I_c}{h_c \cdot A} = \frac{\frac{1}{12} (1) (2)^3}{14 \cdot 2} = \frac{.667}{28} = 0.0238 \text{ ft}$$

$$\Delta_y = 1797.216 \text{ lb} \cdot 0.0238 \text{ ft} = 41.5816 \text{ lb} \cdot \text{ft (clockwise)}$$

$$M_{F_v} = F_v \cdot x_c = 1818.4416 \text{ lb} \cdot 0.894 \text{ ft} = 1625.6916 \text{ lb} \cdot \text{ft (counter-clockwise)}$$

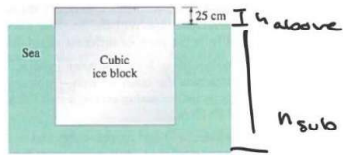
$$M_w = w \cdot R = w \cdot 2 \text{ ft (counter-clockwise)}$$

$$\sum M_A = 0 \rightarrow M_{F_H} + M_{F_v} = M_w$$

$$41.58 + 1625.69 = 2w$$

$$b) \quad w = 833.6416 \text{ lb/ft}$$

3. Consider a large cubic ice block floating in seawater. The specific gravities of ice and seawater are 0.89 and 1.035, respectively. If a 25-cm-high portion of the ice block extends above the surface of the water, determine whether the cubic ice block is stable.



$$h_{\text{above}} = 25 \text{ cm} = 0.25 \text{ m}$$

$$h_{\text{sub}} = H - 0.25$$

$$F_b = W$$

$$\rho_{\text{seawater}} \cdot g \cdot V_{\text{sub}} = \rho_{\text{ice}} \cdot g \cdot V_{\text{total}}$$

$$SG_{\text{seawater}} \cdot h_{\text{sub}} = SG_{\text{ice}} \cdot H$$

$$(1.035 \cdot h_{\text{sub}} = 0.89 \cdot (h_{\text{sub}} + 0.25))$$

$$(1.035 \cdot h_{\text{sub}} = 0.89 \cdot (h_{\text{sub}} + 0.2225))$$

$$(1.035 - 0.89) \cdot h_{\text{sub}} = 0.2225$$

$$h_{\text{sub}} = \frac{0.2225}{0.145} = 1.535 \text{ m}$$

$$H = 1.534 \text{ m} + 0.25 \text{ m} = 1.784 \text{ m}$$

$$y_G = \frac{H}{2} = \frac{1.784 \text{ m}}{2} = 0.892 \text{ m}$$

$$y_B = \frac{h_{\text{sub}}}{2} = \frac{1.534 \text{ m}}{2} = 0.767 \text{ m}$$

$$BG = y_G - y_B = 0.892 \text{ m} - 0.767 \text{ m} = 0.125 \text{ m}$$

$$BM = \frac{I}{V_{\text{sub}}} \rightarrow BM = \frac{H^2}{12 \cdot h_{\text{sub}}} = \frac{(1.784)^2}{12 \cdot 1.534} = 0.173 \text{ m}$$

$$MG = BM - BG$$

$$= 0.173 \text{ m} - 0.125 \text{ m} = +0.048 \text{ m}$$

$MG > 0$, therefore body is stable