2.113 A *spar buoy* is a rod weighted to float vertically, as in Fig. P2.113. Let the buoy be maple wood (SG = 0.6), 2 in by 2 in by 10 ft, floating in seawater (SG = 1.025). How many pounds of steel (SG = 7.85) should be added at the bottom so that h = 18 in?

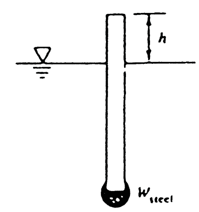


Fig. P2.113

Solution: The relevant volumes needed are

$$\text{Spar volume} = \frac{2}{12}\left(\frac{2}{12}\right)(10) = 0.278\ \text{ft}^3; \quad \text{Steel volume} = \frac{W_{steel}}{7.85(62.4)}$$

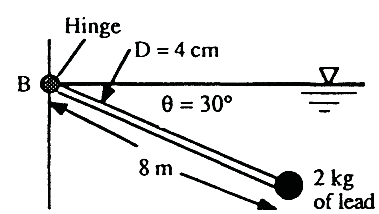
$$\text{Immersed spar volume} = \frac{2}{12}\left(\frac{2}{12}\right)(8.5) = 0.236\ \text{ft}^3$$

The vertical force balance is: buoyancy B = $W_{wood} + W_{steel}$,

$$\text{or:}\quad 1.025(62.4)\left[0.236 + \frac{W_{steel}}{7.85(62.4)}\right] = 0.6(62.4)(0.278) + W_{steel}$$

$$\text{or:}\quad 15.09 + 0.1306W_{steel} = 10.40 + W_{steel}, \quad \text{solve for} \quad W_{steel} \approx \mathbf{5.4\ lbf} \quad \textit{Ans.}$$

2.114 The uniform rod in the figure is hinged at B and in static equilibrium when 2 kg of lead (SG = 11.4) are attached at its end. What is the specific gravity of the rod material? What is peculiar about the rest angle $\theta = 30°$?



Solution: First compute buoyancies: $B_{rod} = 9790(\pi/4)(0.04)^2(8) = 98.42$ N, and $W_{lead} = 2(9.81) = 19.62$ N, $B_{lead} = 19.62/11.4 = 1.72$ N. Sum moments about B:

$$\sum M_B = 0 = (SG - 1)(98.42)(4\cos 30°) + (19.62 - 1.72)(8\cos 30°) = 0$$

$$\text{Solve for} \quad \mathbf{SG_{rod} = 0.636} \quad \textit{Ans.}\ \text{(a)}$$

The angle θ drops out! The rod is neutrally stable for **any tilt angle!** *Ans.* (b)
