

31. For our estimate of $V_{\text{submerged}}$ we interpret “almost completely submerged” to mean

$$V_{\text{submerged}} \approx \frac{4}{3}\pi r_o^3 \quad \text{where } r_o = 60 \text{ cm} .$$

Thus, equilibrium of forces (on the iron sphere) leads to

$$F_b = m_{\text{iron}}g \implies \rho_{\text{water}}gV_{\text{submerged}} = \rho_{\text{iron}}g \left(\frac{4}{3}\pi r_o^3 - \frac{4}{3}\pi r_i^3 \right)$$

where r_i is the inner radius (half the inner diameter). Plugging in our estimate for $V_{\text{submerged}}$ as well as the densities of water (1.0 g/cm^3) and iron (7.87 g/cm^3), we obtain the inner diameter:

$$2r_i = 2r_o \left(1 - \frac{1}{7.87} \right)^{1/3} = 57.3 \text{ cm} .$$