51.1: Archimedes' Principle

One of the simplest principles of fluid statics is Archimedes' principle, which states that if a body is wholly or partially submerged in a fluid, then it is buoyed upward by a buoyant force B equal to the weight of the displaced fluid:

$$B = W \tag{51.1.1}$$

where B is the buoyant force, and $W = \rho g V$ is the weight of the displaced fluid: ρ is the density of fluid displaced, V is the volume of fluid displaced, and g is the acceleration due to gravity.

Suppose we have a body of volume V and density ρ_b completely submerged in a fluid of density ρ_f. What will happen? There will be two forces acting on the body: the weight of the body, acting downward [1] ($W = -\rho_b V g$), and the buoyant force, acting upward $(B = \rho_f V g)$. The net force is then $F = B + W = (\rho_f - \rho_b) V g$. This implies that:

- If $\rho_b = \rho_f$ (the body is the same density as the fluid), then there is no net force on the body.
- If $\rho_b < \rho_f$ (the body is less dense than the fluid), then $F > 0$ and there is a net upward force on the body: the body will float up toward the surface.
- If $\rho_b > \rho_f$ (the body is denser than the fluid), then $F < 0$ and there is a net downward force on the body: the body will sink.

[1] We take positive to be upward, and negative downward.