Buoyancy

Suppose a solid object is immersed in a fluid, with the height d_t to the top of the object and d_b to the bottom.

There are two forces resulting from the atmospheric pressure and pressure of the column of water acting on the solid.

Note that $P_b > P_t$ and thus $(P_b - P_t)A > 0$. Why? Ask Archimedes!

Consider the following, where A is the cross-section area of the solid:

$$(P_b - P_t)A = (P_{atm} + \rho_f g d_b)A - (P_{atm} + \rho_f g d_t)A = \rho_f g(d_b - d_t)A > 0$$

Note that $\rho_f g(d_b - d_t)A = \rho_f g V_{\text{solid}}$, and thus $\mathbf{F} = \rho_f V_{\text{solid}} \mathbf{g}$

The magnitude of the buoyant force, acting upwards on the floating object, determines whether it sinks, floats or goes up. However, the buyoancy force acts does not act on the centre of mass but on the **centre of buoyancy**, so for the stable equilibrium of a floating object to occur, the centre of buyoancy must be above the centre of mass. Mind the torque otherwise!