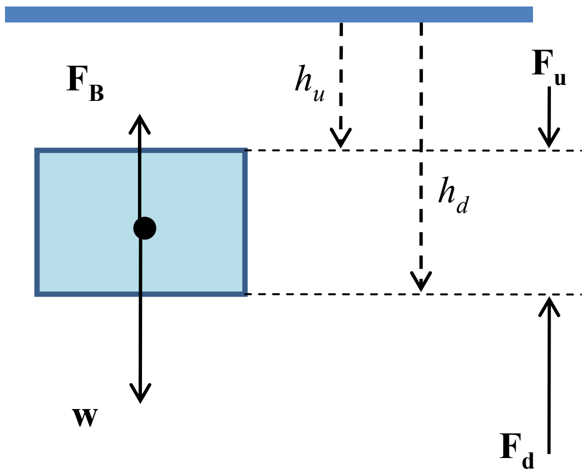
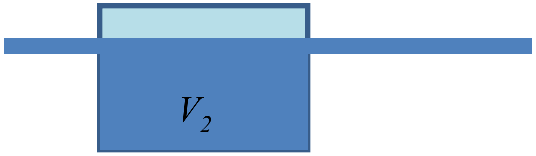
Buoyancy



$$F_B = F_d - F_u$$
$$= \gamma(h_d - h_u)A = \gamma V$$

Archimedes' principle

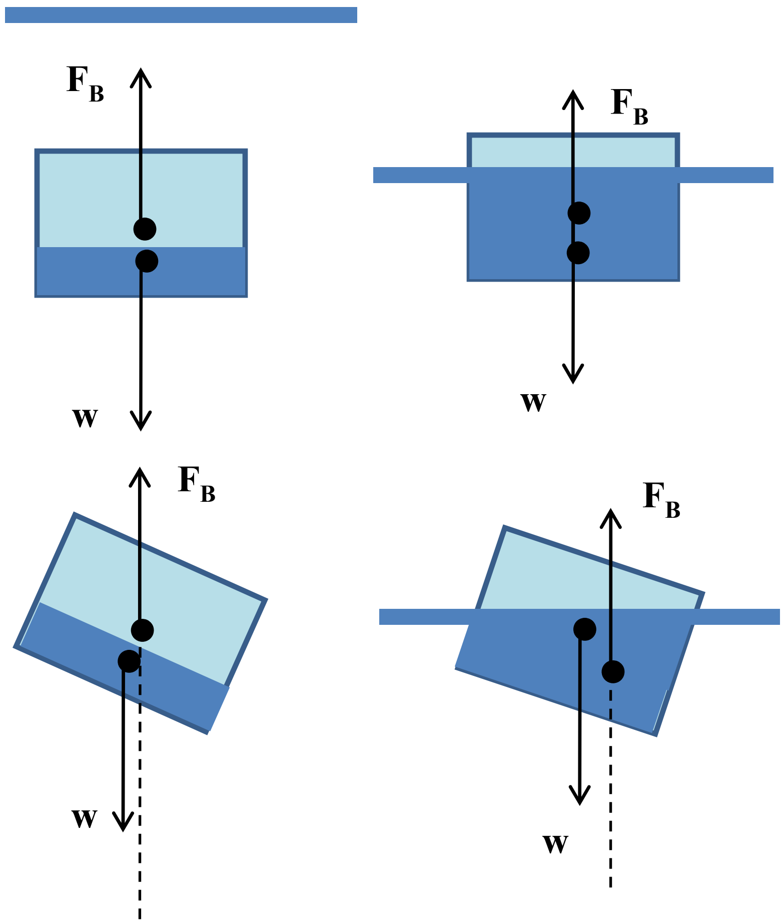
$w > F_B$: the object sinks
$w = F_B$: the object floats



Floating object:

$$F_B = \gamma V_2$$

Buoyancy



Stability:

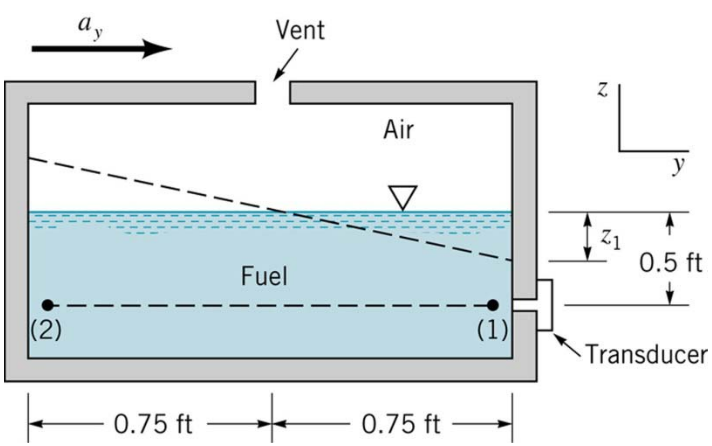
Buoyant force $\mathbf{F_B}$ acts through the center of buoyancy (CB), i.e., the centroid of displaced fluid, while weight **w** acts through the center of gravity (CG).

We will have a nonzero couple when the position of the object is disturbed. We may have either a restoring couple or an overturning couple.

Accelerating fluid

$$\nabla p + (\gamma)\hat{\mathbf{k}} = -\rho \mathbf{a}$$ Eq (2.2)

Cartesian coordinate: $$\nabla p = \frac{\partial p}{\partial x}\hat{\mathbf{i}} + \frac{\partial p}{\partial y}\hat{\mathbf{j}} + \frac{\partial p}{\partial z}\hat{\mathbf{k}}$$



$$dp = \frac{\partial p}{\partial y}dy + \frac{\partial p}{\partial z}dz$$

$$= -\rho a_y dy - \rho g dz$$

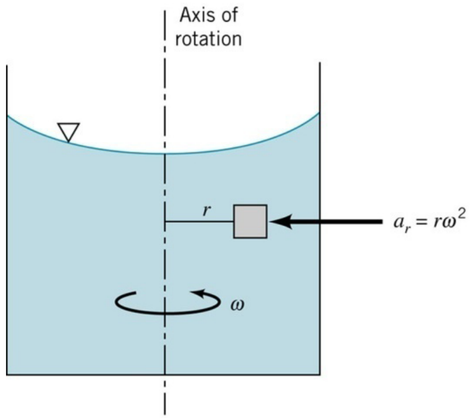
Along the surface: $dp = 0$, so that

$$\frac{dz}{dy} = -\frac{a_y}{g}$$

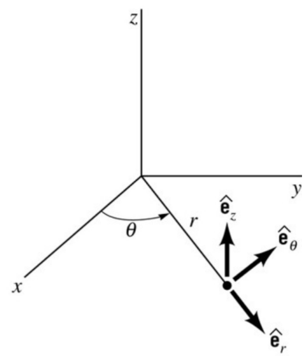
Accelerating fluid

$$\nabla p + (\gamma)\hat{\mathbf{k}} = -\rho \mathbf{a}$$ Eq (2.2)

Cylindrical coordinate: $$\nabla p = \frac{\partial p}{\partial r}\hat{\mathbf{e}}_r + r\frac{\partial p}{\partial \theta}\hat{\mathbf{e}}_\theta + \frac{\partial p}{\partial z}\hat{\mathbf{e}}_z$$ Eq (2.29)



(b)



(c)

$$dp = \frac{\partial p}{\partial r}dr + \frac{\partial p}{\partial z}dz$$

$$= -\left(-\rho r \omega^2\right)dr - \rho g dz$$

Along the surface: $dp = 0$, so that

$$\frac{dz}{dr} = \frac{r\omega^2}{g}$$