

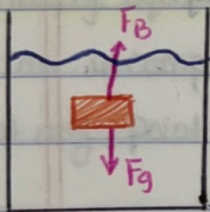
Chapter 12: Buoyancy

* **Buoyant Force**: is an upward force due to the pressure difference above and below an object.

$$F_B = \rho_f V_{sub} g$$

V_{sub} : volume of fluid displaced by the object.

* **Archimedes' Principle**: the magnitude of the buoyant force is equal to the weight of the displaced fluid.

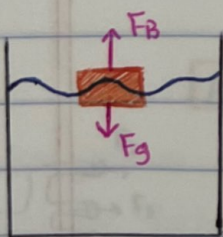


If the object is sinking, the weight of the object has to be greater than the Buoyant force. $F_g > F_B$

$$\rho_{obj} V_{obj} g > \rho_{fluid} V_{sub} g \quad (V_{obj} = V_{fluid})$$

$$\rho_{obj} > \rho_{fluid}$$

⇒ Objects fully immersed in fluid displace a volume of fluid equal to its own Volume.



$$F_g = F_B$$

$$\rho_{obj} V_{obj} g = \rho_f V_{sub} g$$

$$\rho_{obj} V_{obj} = \rho_f V_{sub}$$

$$\frac{\rho_{obj}}{\rho_{fluid}} = \frac{V_{sub}}{V_{obj}}$$

* Bernoulli's Equation:

Describes ideal fluid flow. (Incompressible fluid, laminar flow, no viscosity)

Derived from conservation of energy. No turbulence

$$P_1 + \frac{1}{2} \rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2} \rho v_2^2 + \rho g h_2$$

Example: What is the density of an object floating in water if 30% of the object is above water?

$$\rho_{obj} < \rho_{fluid}$$

A) 0.3 g/ml

$$\frac{V_{sub}}{V_{obj}} = \frac{70\%}{100\%} \rightarrow \text{below the water.}$$

B) 0.7 g/ml

C) 1.3 g/ml } object not sinking.
D) 1.7 g/ml } $\Rightarrow \rho_{obj} = 0.7 \text{ g/ml}$

Example: Suppose the mass of your friend is 62 kg and he displaces 0.025 m^3 when completely immersed in the swimming pool. What is his apparent weight when immersed in the pool? The average density of a chlorinated water is 993 kg/m^3 .

$$F_b = \text{actual weight} - \text{Apparent weight}$$

$$F_g - F_b = 62(9.8) - A_w$$

$$993 \times 9.8 \times 0.025 = 607.6 - A_w$$

$$243.28 - 607.6 = -A_w \Rightarrow A_w = 364.32 \text{ N}$$

$$\frac{\rho_{obj} V}{\rho_{fluid} V} = \frac{m_{obj}}{m_{fluid}}$$

$$\rho_{obj} V A = \rho_{fluid} V A$$

$$\rho_{obj} A = \rho_{fluid} A$$