Chapter 12 :- Buoyancy

* when an object is submerged in a fluid, there is an upward force called the buoyant force

→ Archimedes' Principle :-

states that the buoyant force on an object is equal to the weight of the fluid it places.

→ Buoyancy :- is the upward force exerted on an object that is fully or partially submerged in a fluid, resulting from the increase in pressure with depth.

* this force allows some objects to float on a liquid, while other sink.

$$F_{buoyant} = m_f g = \rho_f V_s g$$

m_f : mass of the fluid displaced

V_f : Volume of the fluid displaced.

ρ_f : fluid density.

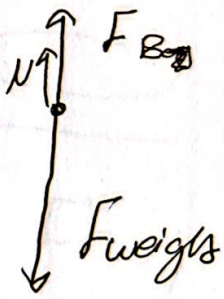
⟹ The net downwards force on the object in the case of only the buoyant force and gravity acting is

$$F_{net} = mg - \rho_f V_f g$$

$$= \rho_{obj} V_{obj} g - \rho_f V_f g$$

* (a) if $\rho_{obj} < \rho_f$ $\quad V_{disp} < V_{obj}$ (partially submerged)

(b) if $\rho_{obj} > \rho_f$ $\quad V_{disp} = V_{object}$ (sink)



2 cases → floating (a)

→ sink (b)

$F_{net} = 0 = \rho_{obj} V_{obj} g - \rho_f V_{disp} g$ "floating object is stationary"

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

$$\boxed{\frac{V_{disp}}{V_{obj}} = \frac{\rho_{obj}}{\rho_f}}$$

* example:

* $\rho_{obj} = \frac{\rho_f}{2}$

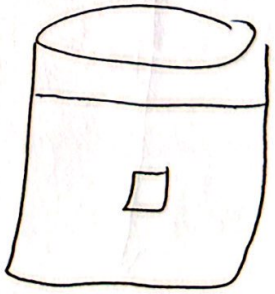
$$\frac{V_{disp}}{V_{obj}} = \frac{\frac{\rho_f}{2}}{\rho_f}$$

$$V_{disp} = \frac{1}{2} V_{obj}$$

* $\rho_{obj} = \frac{7}{8} \rho_f$.

$$V_{disp} = \frac{7}{8} V_{obj}$$

* $\rho_{object} = \rho_f$ $V_{disp} = V_{obj}$



∴ any submerged object has an apparent weight that is not the same as its actual weight

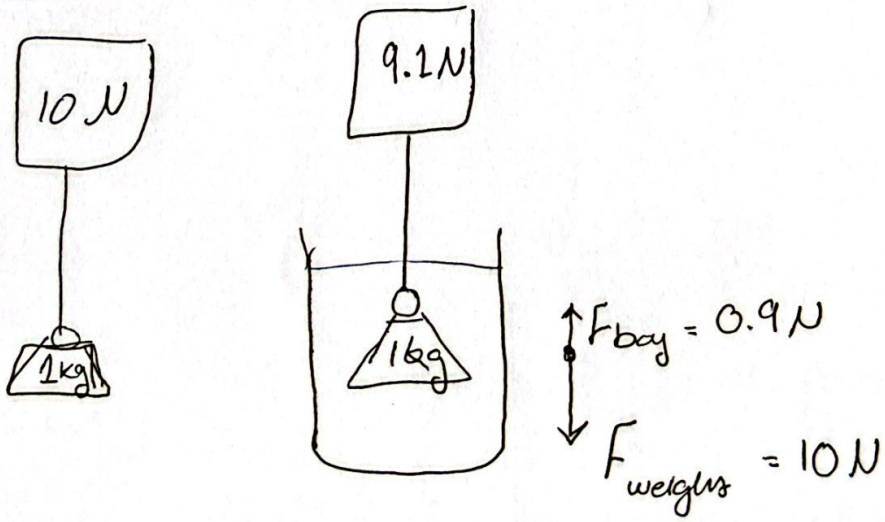
$$\text{apparent weight} = \text{actual weight} - \text{buoyant force}$$

$$\therefore \text{buoyant force} = \text{apparent weight} + \text{actual weight}$$

$$\frac{\rho_f V g}{mg} = \frac{\text{actual weight} - \text{apparent weight}}{\text{actual weight}}$$

$$= \frac{\rho_f V g}{\rho_{obj} V g} = \frac{\rho_f}{\rho_{obj}}$$

Figure 12.4



See example 12.1, 12.2, 12.3, 12.4