CE 319 F

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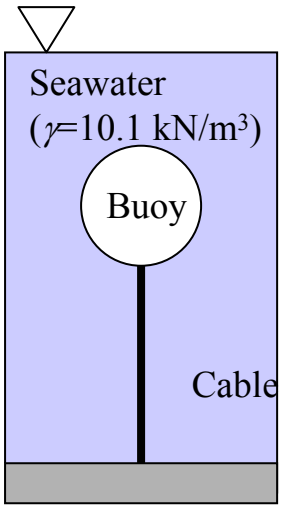
Elementary Mechanics of Fluids

Buoyancy

Example



Spherical buoy has a diameter of 1.5 m, weighs 8.50 kN, and is anchored to the sea floor with a cable as shown. The buoy normally floats on the surface, at other times the water depth increases so that the buoy is completely immersed as shown. What is the tension in the cable?

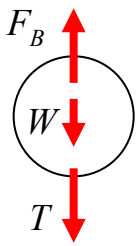
$$\sum_y F_y = 0 = F_B - W - T$$

$$F_B = \gamma \forall = \gamma \frac{\pi}{6} d^3 = (10{,}100\, N/m^3)\frac{\pi}{6}(1.5\, m)^3 = 17{,}850\, N$$

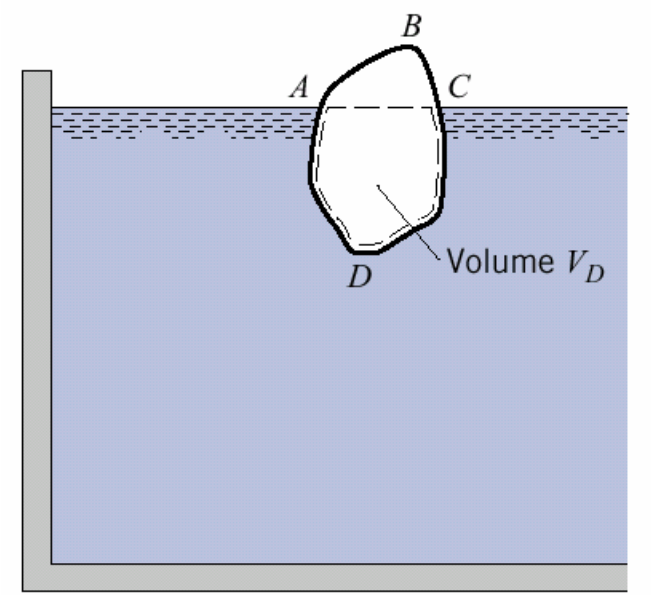
$$T = F_B - W$$

$$= 17{,}850 - 8{,}500\, N$$

$$= 9{,}350\, N$$



Archimedes Principle

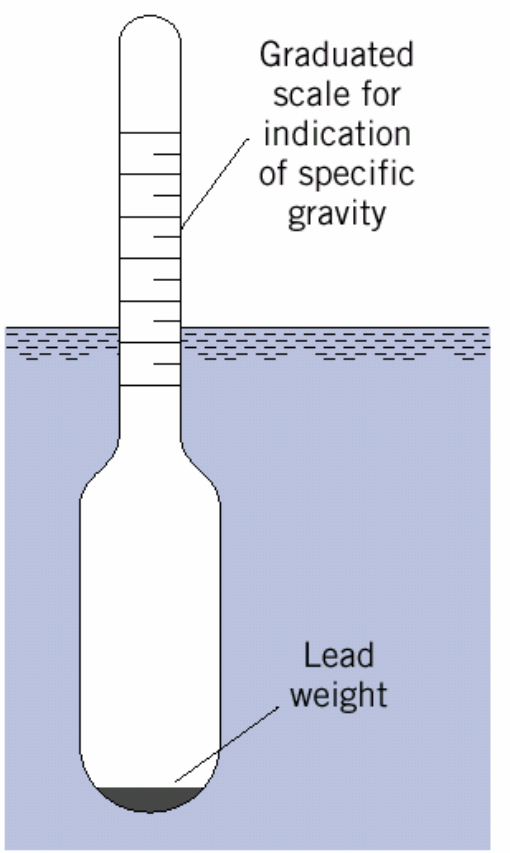


- Archimedes Principle

$$F_B = \text{weight displaced fluid}$$

- Line of action passes through the centroid of displaced volume

Hydrometer



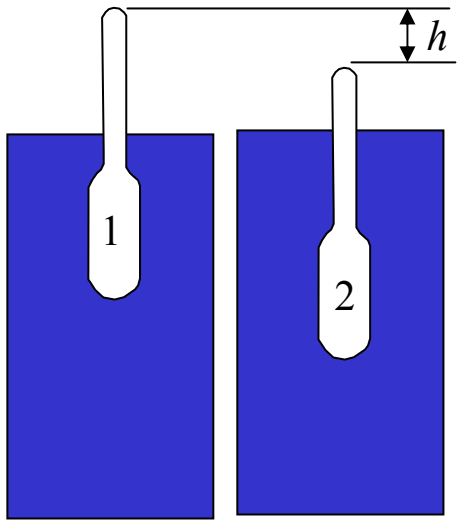
- Buoyant force

  F_B = weight of the hydrometer

  must remain constant

- Hydrometer floats deeper or shallower depending on the specific weight of the fluid

Example



A hydrometer weighs 0.0216 N and has a stem at the upper end that is cylindrical and 2.8 mm in diameter.

How much deeper will it float in oil of S=0.78 than in alcohol of S=0.821?

For position 1:

$$W_{hydrometer} = W_{displaced\ water}$$

$$0.0216 = 0.821 * 9810 * V_1$$

$$V_1 = 2.68x10^{-6}\ m^3$$

For position 2:

$$W_{hydrometer} = W_{displaced\ water}$$

$$0.0216 = 0.780 * 9810 * (V_1 + Ah)$$

$$= 0.780 * 9810 * [2.68x10^{-6} + \frac{\pi}{4}(0.0028)^2 h]$$

$$h = 0.0232\,m = 23.2\,mm$$