7th class foundation + ①

WS - 19. Flotation

T task

①

let the total volume of a body is V

Volume inside water $V_{in} = \frac{6}{10} V = \frac{3}{5} V$.

we know that $V_{in} = \frac{\text{density of the body}}{\text{density of Liquid}} V$

$$\Rightarrow \frac{3}{5} \cancel{V} = \frac{d_b}{d_w} \cancel{V}$$

$$\Rightarrow d_b = \frac{3}{5} \times d_w = 0.6\, d_w$$

For $d_w = 1\,gm/cc$ $\quad d_b = 0.6\ gm/cc$

$d_w = 10^3\ kg/m^3 \Rightarrow d_b = 600\ kg/m^3$

②

Volume of A $V_A = V_1$

Volume of A inside water $V_{Ain} = \frac{1}{2} V_1$

volume of B $V_B = V_2$

Volume of B inside water $V_{Bin} = \frac{2}{3} V_2$

We know that $V_{in} = \frac{d_b}{d_L} V \Rightarrow d_b = \frac{V_{in}}{V} d_L$

$$\frac{d_A}{d_B} = \frac{\frac{V_{Ain}}{V_1} \cancel{d_w}}{\frac{V_{Bin}}{V_2} \cancel{d_w}} = \frac{\frac{\frac{1}{2} \cancel{V_1}}{\cancel{V_1}}}{\frac{\frac{2}{3} \cancel{V_2}}{\cancel{V_2}}} = \frac{\frac{1}{2}}{\frac{2}{3}} = \frac{3}{4}$$

(3)

$d_{ice} = 0.9$ gm/cc $\qquad V_{ice} = 100$ cc

$d_w = 1$ gm/cc

$$\Rightarrow V_{in} = \frac{d_{ice}}{d_w} V = \frac{0.9}{1} V = 0.9 \times 100 = 90 \text{ cc}$$

(4)

Density of wood $d_w = 0.6$ gm/cc.

volume of wood $V = 8 \text{ cm} \times 8 \text{ cm} \times 4 \text{ cm}$

$$\Rightarrow 256 \text{ cm}^3 = 256 \times 10^{-6} \text{ m}^3$$
$$= 2.56 \times 10^{-4}$$

$d_w = 1$ gm/cc

We know that $V_{in} = \frac{d_b}{d_L} V_{Total}$

$$\Rightarrow V_{in} = \frac{0.6}{1} \times 256 \times 10^{-6}$$

$$\Rightarrow 153.6 \times 10^{-6}$$

$$\Rightarrow 1.536 \times 10^{-4} \text{ m}^3$$

volume outside of water $= V_{Total} - V_{in}$

$$\Rightarrow 2.56 \times 10^{-4} - 1.536 \times 10^{-4}$$

$$\Rightarrow 1.024 \times 10^{-4} \text{ m}^3$$

(8)

we know $d_w = 10^3 \text{ kg/m}^3 = 1 \text{ gm/cc}$.

$$V_{in} = \frac{2}{3} V$$

$$\Rightarrow V_{in} = \frac{d_b}{d_w} V$$

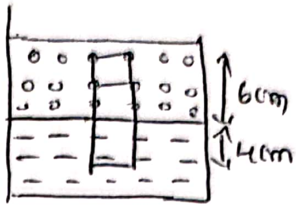
$$\Rightarrow \frac{2}{3} \cancel{V} = \frac{d_b}{10^3} \cancel{V}$$

$$\Rightarrow d_b = \frac{2}{3} \times 10^3 \text{ kg/m}^3 \text{ (or) } \frac{2}{3} \text{ gm/cc}$$

(5)

For the given question Diagram

weight of block = weight of oil displaced + weight of water displaced



$= d_{oil} V_{in o} g + d_w V_{in w} g$

$\Rightarrow (10 \times 10 \times 6) \times 0.6\, g + (10 \times 10 \times 4) 1\, g$

$Mg \Rightarrow 600 \times 0.6\, g + 400\, g$

$\Rightarrow 360\, g + 400\, g$

$\Rightarrow M\cancel{g} = 760\, \cancel{g}$ $\Rightarrow M = 760$ gms

$V_{in oil} = l \times b \times h_{in o}$
$= (10 \times 10 \times 6)\ cm^3$

$V_{in water} = l \times b \times h_{in w}$
$= (10 \times 10 \times 4)\ cm^3$

(6)

Take solution from (4) and continue

Mass of the wood that must be placed

$= d_w \times V_{out} \times g$

$= 10^3 \times 1.024 \times 10^{-4} \times 10$

$\Rightarrow 1.024$ kg

(10)

$V_{in} = \frac{4}{5} V$ and we know that $V_{in} = \frac{d_b}{d_w} V$

density of water $d_w = 10^3\ kg/m^3$

$\Rightarrow \frac{4}{5} \cancel{V} = \frac{d_b}{1000} \cancel{V}$

$\Rightarrow d_b = \frac{4}{5} \times 1000 = 800\ kg/m^3$

(7)

$d_b = 0.6 \ gm/cc$

Volume of wood $V = 8 cm \times 8 cm \times 4 cm$

$= 256 \ cm^3$

$= 256 \times 10^{-6} \ m^3$

$d_w = 1 \ gm/cc.$

$V_{in} = \frac{d_b}{d_w} V \Rightarrow \frac{0.6}{1} \times 256 \times 10^{-6}$

$\Rightarrow 1.536 \times 10^{-4}$

$\Rightarrow 1.54 \times 10^{-4} \ m^3$

(9)

Area of boat $A = 2 m^2$

Mass $m = 76 \ kg$

density of water $d_w = 10^3 \ kg/m^3$

Now weight of man acting downwards on the boat will be balanced by the buoyant force acting on the boat in upward direction.

$\Rightarrow Mg = d A h g$

$\Rightarrow M = d A \times h$

$\Rightarrow h = \frac{M}{dA} = \frac{76}{10^3 \times 2} = \frac{38}{10^3}$

$\Rightarrow h = 38 \times 10^{-3}$

$= 3.8 \times 10^{-2} m$

$= 3.8 cm$

(15)

let V_A, V_B be the volumes of A and B

Volume of A inside water $V_{in\,A} = \frac{1}{3} V_A$

volume of B inside of water $V_{in\,B} = \frac{2}{5} V_B$

we know that $V_{in} = \frac{d_{body}}{d_w} V$

$$\Rightarrow \frac{V_{in}}{V} = \frac{d_{body}}{d_w}$$

$$\therefore \frac{\left(\frac{V_{in}}{V_1}\right)_A}{\left(\frac{V_{in}}{V_1}\right)_B} = \frac{d_A}{d_B}$$

$$\Rightarrow \frac{\frac{1}{3}}{\frac{2}{5}} = \frac{d_A}{d_B} \Rightarrow \frac{d_A}{d_B} = \frac{5}{6}$$

(16)

Mass of beaker + Mass of water = 50 gm

volume of wood $V = 5\,c.c$; $d_{wood} = 0.8\ gm/cc$

$\Rightarrow$ weight of the body = weight of water displaced

$$\Rightarrow d_{body} \times V_{b} \times g = M_w \times g$$

$$\Rightarrow 0.8 \times 5 = M_w \Rightarrow M_w = 4\ gm.$$

$\therefore$ we know that $M_{beaker} + M_{water} = 50$

$$\Rightarrow M_{beaker} = 50 - M_w = 50 - 4 = 46\ gm$$

(17)

$d_{ice} = 917 \ kg/m^3$: $d_{water} = 1000 \ kg/m^3$

we know that $V_{in} = \frac{d_{body}}{d_w} V \Rightarrow \frac{V_{in}}{V} = \frac{d_{body}}{d_w}$

volume fraction of volume above the water

$$\frac{V_o}{V} = \frac{V - V_{in}}{V} = 1 - \frac{V_{in}}{V}$$

$$= 1 - \frac{d_{body}}{d_w}$$

$$= 1 - \frac{917}{1000}$$

$$= \frac{1000 - 917}{1000} = \frac{83}{1000}$$

$$= 0.083$$

L Task

(1)

let the volume of rubber $= V$: $V_{outside} = \frac{1}{3} V$

density of rubber $= d_r$: $d_{water} = 10^3 \ kg/m^3$

we know that volume inside of water $= V_{in} = \frac{d_{body}}{d_{water}} V$

$\Rightarrow V_{in} = V - V_{out} = V - \frac{1}{3} V = \frac{2}{3} V$

$\therefore \frac{2}{3} \cancel{V} = \frac{d_r}{10^3} \cancel{V} \Rightarrow d_r = \frac{2}{3} \times 10^3 = 667 \ kg/m^3$

1(3) ②, ③

Volume of wood $= 0.032\ m^3$

Mass of wood $m = 24\ kg$.

$$d_{wood} = \frac{m}{V} = \frac{24}{0.032} = \frac{24 \times 10^3}{32} = \frac{3}{4} \times 10^3\ kg/m^3$$

Volume inside of water $= V_{in} = \frac{d_{wood}}{d_{water}} V$

$$\Rightarrow V_{in} = \frac{\frac{3}{4} \times 10^3}{10^3} \times 0.032$$

$$= \frac{3}{4} \times 0.032 = 3 \times 0.008$$

$$= 0.024\ m^3.$$

④

Given mass of wood $= 700\ gm$; $d_w = 1\ gm/cc$

side length $l = 10\ cm. \Rightarrow$ volume of cube $= (Side)^3 = 1000\ cm^3$

when wood is floating on water

weight of the body = weight of water displaced

$$\Rightarrow Mg = d_w \times V_{in}\ g$$

$$\Rightarrow 700 = 1 \times V_{in}$$

$$\Rightarrow V_{in} = 700\ cm^3$$

$$V_{out} = V - V_{in} = 1000 - 700 = 300\ cm^3$$

⑤ Given $d_{wax} = 0.95\ gm/cc$; $d_{brine} = 1.1\ gm/cc$

Volume inside of brine $= V_{in} = \frac{d_{wax}}{d_{brine}} V \Rightarrow \frac{0.95}{1.1} V = \frac{9.5}{11} V$

$$\frac{V_{in}}{V} = \frac{9.5}{11} = 0.86$$

(6)

density of ice $d_{ice} = 0.9$ gm/cc

$d_{water} = 1.1$ gm/cc

Volume inside of water $V_{in} = \frac{d_{ice}}{d_w} V$

$= \frac{0.9}{1.1} V$

$= \frac{9}{11} V$

(7)

density of ice $d_{ice} = 0.92$ gm/cc

$d_w = 1.025$ g/cc

volume of ice berg $= V$; volume outside $V_{out} = 800 cm^3$

we know that Volume of iceberg inside water

$V_{in} = \frac{d_{ice}}{d_{water}} V$

$\Rightarrow V_{in} = \frac{0.92}{1.025} = \frac{92}{102.5} V = 0.8976 V$

Volume outside of water $V_{out} = V - V_{in}$

$= V - 0.8976 V$

$\Rightarrow 800 = V(1 - 0.8976)$

$\Rightarrow V = \frac{800}{1 - 0.8976} = 7812.5$ gm/cc

(8)

(5)

$d_{brine} = 1.2$ gm/cc ; Voutside of brine $V_{out} = \frac{3}{8}V$.

we know that $V_{in} = \frac{d_{body}}{d_L} V$; $V_{in} = V - V_{out}$

$\Rightarrow V - V_{out} = \frac{d_{wood}}{d_{brine}} V$

$\Rightarrow V - \frac{3}{8}V = \frac{d_w}{1.2} V$

$\Rightarrow \frac{5}{8}\cancel{V} = \frac{d_{wood}}{1.2}\cancel{V} \Rightarrow d_{wood} = \frac{5}{8} \times 1.2 = \frac{6}{8} = \frac{3}{4} = 0.75$ gm/cc

$\Rightarrow d_{wood} = 0.75$ gm/cc.

(9)

volume of block that floats in water $= V_{in} = V - V_{out}$

volume of block that floats above water $= V_{out} = \frac{3}{10}V$

$\therefore V_{in} = V - \frac{3}{10}V = \frac{7}{10}V.$

density of salt solution $d_L = 1.05$ gm/cc.

$\therefore$ From $V_{in} = \frac{d_{body}}{d_L} V$

$\Rightarrow \frac{7}{10}\cancel{V} = \frac{d_{body}}{1.05}\cancel{V}$

$\Rightarrow d_{body} = \frac{7}{10} \times 1.05 = \frac{7.35}{10} = 0.\ \simeq \frac{7}{10}$ gm/cc

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(10)

Area of wood = A $\quad$ $\therefore d_{water} = 1$ gm/cc

height $h = 15$ cm

So volume of wood $= A \times h = 15A \cdot cm^3$

height of ~~wat~~ wood in water $h_{in\,w} = 10$ cm

$V_{in\,water} = 10A\ cm^3$

height of wood in spirit $= h_{in\,spirit} = 12$ cm

$V_{in\,spirit} = 12A\ cm^3$

From
$$V_{in} = \frac{d_{wood}}{d_{Liquid}} \cdot V.$$

For water
$$V_{in\,water} = \frac{d_{wood}}{d_w} \times V$$

$$\Rightarrow 10\cancel{A} = \frac{d_{wood}}{1} \times 15\cancel{A}$$

$$\Rightarrow d_{wood} = \frac{10}{15} = \frac{2}{3} = 0.667\ gm/cc$$

For spirit
$$V_{in\,spirit} = \frac{d_{wood}}{d_{spirit}} V.$$

$$\Rightarrow 12\cancel{A} = \frac{\frac{2}{3}}{d_{spirit}} 15\cancel{A}$$

$$\Rightarrow \cancel{12}^{6} = \frac{\cancel{2}}{\cancel{3}\,d_{spirit}} \cancel{15}\ 5$$

$$\Rightarrow 6 = \frac{5}{d_{spirit}}$$

$$\Rightarrow d_{spirit} = \frac{5}{6} = 0.83\ gm/cc.$$

(ii)

Volume of wooden block $= V$

Volume inside of water $= V_{in} = \frac{2}{3}V$

density of water $= d_w = 10^3\ kg/m^3$

Volume of block inside of oil $= V_{in\,oil} = \frac{3}{4}V$

We know that $V_{in} = \frac{d_{body}}{d_{Liquid}} V$

For water

$$V_{inw} = \frac{d_b}{d_w} V$$

$$\Rightarrow \frac{2}{3}\cancel{V} = \frac{d_b}{10^3}\cancel{V}$$

$$\Rightarrow d_b = \frac{2}{3} \times 10^3 = 667\ kg/m^3$$

For oil

$$V_{in\,oil} = \frac{d_b}{d_{oil}} V$$

$$\Rightarrow \frac{3}{4}\cancel{V} = \frac{\frac{2}{3}\times 10^3}{d_{oil}}\cancel{V}$$

$$\Rightarrow d_{oil} = \frac{4}{3} \times \frac{2}{3} \times 10^3 = \frac{8}{9} \times 10^3 = 889\ kg/m^3$$

(14)

$d_{ice} = 917\ kg/m^3$; $d_{water} = 1000\ kg/m^3$

volume inside of water $= V_{in} = \frac{d_{ice}}{d_{water}} V$

$$= \frac{917}{1000} V$$

$\therefore$ volume outside $V_{out} = V - V_{in} = V - \frac{917}{1000}V$

$$= \frac{83}{1000} V$$

$$\frac{V_{out}}{V} = \frac{83}{1000} = 0.083$$

(15)

$d_{brine} = 1.2$ gm/cc

Volume of wooden block = V

Volume outside of brine = $\frac{3}{8}V$.

$V_{out} = \frac{3}{8}V$.

$\Rightarrow V_{in} = V - V_{out} = V - \frac{3}{8}V$

$= \frac{5}{8}V$.

$\therefore$ volume inside brine $V_{in} = \frac{d_{wood}}{d_{brine}} V$

$\Rightarrow \frac{5}{8} \cancel{V} = \frac{d_{wood}}{1.2} \cancel{V}$

$\Rightarrow d_{wood} = \frac{5}{8} \times 1.2 = \frac{6}{8}$

$= \frac{3}{4} = 0.75$ gm/cc

(16)

density of an object $= d_{body} = d_0$

density of a liquid $= d_{liquid} = d$

volume of object $= V_0$

we know $V_{in} = \frac{d_{body}}{d_{liquid}} V$

$V_{in} = \frac{d_0}{d} V$

Volume outside $V_{out} = V - V_{in} = V - \frac{d_0}{d} V$

$V_{out} = V\left[1 - \frac{d_0}{d}\right]$

$\frac{V_{out}}{V} = \frac{d - d_0}{d}$

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