7th class foundation

WS-19 Flotation

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

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

(3)

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

$d_w = 1$ gm/cc

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

(4)

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

volume of wood $V = 8\,cm \times 8\,cm \times 4\,cm$

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

$= 2.56 \times 10^{-4}$

$d_w = 1$ gm/cc

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

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

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

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

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

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

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

(8)

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

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

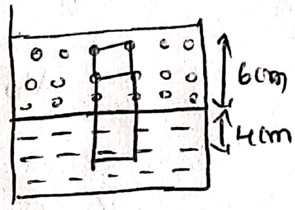
$\Rightarrow V_{in} = \frac{d_b}{d_w} V$

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

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

(5)

For the given question Diagram



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

$= d_{oil} V_{ino} g + d_w V_{inw} g$

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

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

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

$\Rightarrow Mg = 760\, g \quad \Rightarrow M = 760$ gm

$V_{in\,oil} = l \times b \times h_{ino}$ $\qquad$ $V_{in\,water} = l \times b \times h_{inw}$

$= (10 \times 10 \times 6)\ cm^3$ $\qquad$ $= (10 \times 10 \times 4)\ cm^3$

(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)

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

density of water $d_w = 10^3\ kg/m^3$ $\qquad$ $\Rightarrow \frac{4}{5} \cancel{V} = \frac{d_b}{1000} \cancel{V}$

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

(7)

$d_b = 0.6$ gm/cc

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

$= 256\ cm^3$

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

$d_w = 1$ 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 $A = 2m^2$

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.

$\Rightarrow Mg = dAhg$

$\Rightarrow M = dA \times h$

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

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

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

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

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

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

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

(2) , (3)

Volume of wood $= 0.032\ m^3$

Mass of wood $m = 24\ kg$.

$$d_{wood} = \frac{m}{V} = \frac{24}{0.032} = \frac{24\times10^3}{32} = \frac{3}{4}\times10^3\ kg/m^3$$

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

$$\Rightarrow V_{in} = \frac{\frac{3}{4}\times10^3}{10^3}\times 0.032$$

$$= \frac{3}{4}\times0.032 = 3\times0.008$$

$$= 0.024\ m^3.$$

(4)

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

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 $d_{wood} = 0.95\ gm/cc$; $d_{brine} = 1.1\ gm/cc$

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

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

(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)

$d_{brine} = 1.2$ gm/cc ; $V_{outside}$ 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 $V_{in} = \frac{d_{body}}{d_L} V$

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

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

(10)

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

height $h = 15$ cm

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

height of ~~wat~~ wood in water $h_{inw} = 10$ cm

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

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

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

From $\quad V_{in} = \dfrac{d_{wood}}{d_{Liquid}} V$

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

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

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

For spirit

$V_{in\,spirit} = \dfrac{d_{wood}}{d_{spirit}} V$

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

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

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

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

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(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 $= d_{body} = d_o$

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

volume of object $= V_o$

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

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

volume outside $V_{out} = V - V_{in} = V - \frac{d_o}{d} V$

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

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