Physicsaholics

DPP – 2

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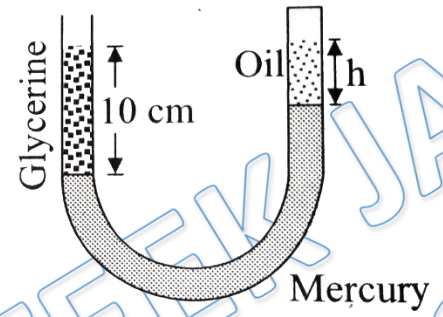
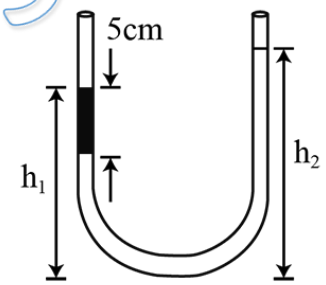
Q 1. A vertical U tube of uniform inner cross-section containing mercury in both its arms. A glycerin (density 1300 kgm^{-3}) column of length 10 cm is introduced into one of the arms. Oil of density (800 kgm^{-3}) is poured in the other arm until the upper surface of the oil and the glycerin are in the same horizontal surface. Find the length of oil column (Density of mercury = 13.6×10^3 kgm^{-3})



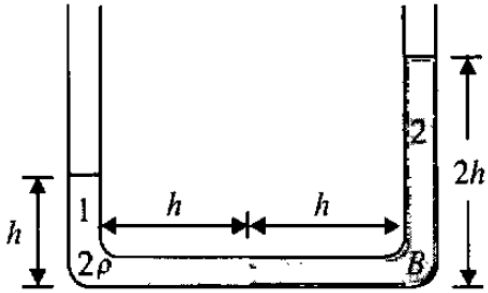
(a) 10.4 cm (b) 8.2 cm
(c) 7.2 cm (d) 9.6 cm

Q 2. An open-ended U-tube of a uniform cross-sectional area contains water (density 1.0 gm/cm^3) standing initially 20 cm from the bottom in each arm. An immiscible liquid of density 4.0 gm/cm^3 is added to one arm until a layer of 5 cm high forms, as shown in the figure above. What is the ratio $\frac{h_2}{h_1}$ of the heights of the liquid in the two arms?



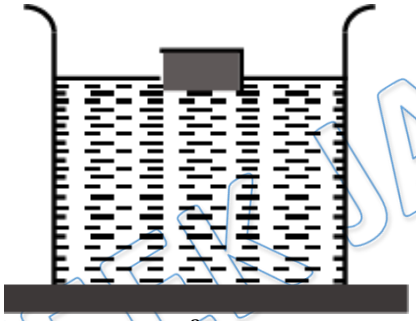
(a) $\frac{3}{1}$ (b) $\frac{5}{2}$
(c) $\frac{2}{1}$ (d) $\frac{3}{2}$

Q 3. A vertical U-tube has two liquid 1 and 2. The height of liquids columns in both the limbs are h and 2h, as shown in the figure. If the density of the liquid 1 is 2ρ. Find the density of liquid 2.



(a) ρ (b) 2ρ
(c) 3ρ (d) 4ρ

Q 4. A uniform cube of mass M is floating on the surface of a liquid with three fourth of its volume immersed in the liquid (density=ρ). The length of the side of the cube is equal to

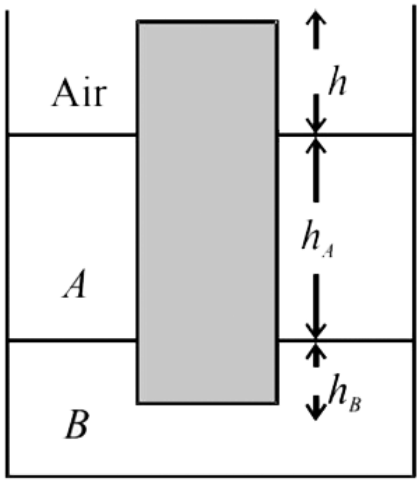


(a) $\left(\frac{4M}{3\rho}\right)^{\frac{2}{3}}$ (b) $\left(\frac{M}{3\rho}\right)^{\frac{2}{3}}$
(c) $\left(\frac{M}{4\rho}\right)^{\frac{2}{3}}$ (d) none of these

Q 5. A cube of side 20 cm is floating on a liquid with 5 cm of the cube outside the liquid. If the density of liquid is 0.8gm/cc then the mass of the cube is
(a) 4.2 kg (b) 4.8 kg
(c) 5 kg (d) 5.2 kg

Q 6. A cube of side 4cm is just completely immersed liquid A. When it is put in liquid B, it floats with 2 cm outside the liquid. Calculate the ratio for densities of two liquids.
(a) $\frac{1}{2}$ (b) $\frac{1}{4}$
(c) $\frac{1}{3}$ (d) $\frac{1}{2.5}$

Q 7. A uniform solid cylinder of density 0.8g/cm^3 floats in equilibrium in a combination of two non-mixing liquids A and B with its axis vertical. The densities of the liquids A and B are 0.7g/cm^3 and 1.2g/cm^3, respectively. The height of liquid A is h_A = 1.2cm. The length of the part of the cylinder immersed in liquid B is h_B = 0.8cm. Find h, the length of the part of the cylinder in air.

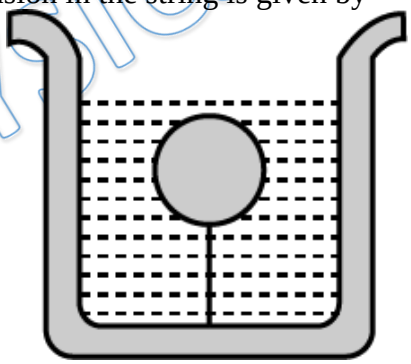


(a) 2.5 cm (b) 0.25 cm
(c) 1.25 cm (d) 2.25 cm

Q 8. A wooden plank immerses up to 50% in water. Then _____ % of it is immersed in a liquid of density 0.5 g/cm^3
(a) 90 % (b) 50 %
(c) 75 % (d) 100 %

Q 9. A log of wood of mass 120 Kg floats in water. The weight that can be put on the raft to make it just sink, should be (density of wood = 600 Kg/m^3)
(a) 80 kg (b) 50 kg
(c) 60 kg (d) 30 kg

Q 10. A solid sphere of density η (> 1) times lighter than water (density =1 unit) is suspended in a water tank by a string tied to its base as shown in fig. If the mass of the sphere is m then the tension in the string is given by



(a) $\left(\frac{\eta-1}{\eta}\right)mg$ (b) ηmg
(c) $\frac{mg}{\eta-1}$ (d) $(\eta-1)mg$

Q 11. In a hydraulic machine, a force of 2N is applied on the piston of area of cross section 10 cm^2. What force is obtain on its piston of area of cross section 100 cm^2
(a) 2 N (b) 4 N
(c) 10 N (d) 20 N

Q 12. A hydraulic lift is used to lift a car of mass 3000 kg. The cross-sectional area of the lift on which the car is supported is 5×10^{-2} m. What is the pressure on the smaller piston, if both the pistons are at the same horizontal level? Take g=10 m/s^2.
(a) $3 \times 10^3\ N/m^2$ (b) $2 \times 10^4\ N/m^2$
(c) $5 \times 10^7\ N/m^2$ (d) $6 \times 10^5\ N/m^2$

Q 13. To lift an automobile of 2000kg a hydraulic pump with a larger piston 900 cm^2 in area is employed. Calculate the force that must be applied to pump a small piston of area 10 cm^2 to accomplish this task.
(a) 312.6 N (b) 72.4 N
(c) 222.2 N (d) 441.4 N

Q 14. Calculate the work done in raising a stone of mass 6 kg of specific gravity 2, immersed in water from a depth of 4m to 1m below the surface of water (g = 10 m/s^2).
(a) 150 J (b) 60 J
(c) 90 J (d) 180 J

Q 15. The buoyant force on a body in a liquid depends on
(a) total depth of the liquid
(b) density of the liquid
(c) density of body
(d) none of these

Q 16. The reading of a spring balance when a block suspended from it is air 60 newton. This reading changed to 40 newton when the block is fully submerged in water . The specific gravity of the block must be therefore:
(a) 3 (b) 2
(c) 6 (d) $\frac{3}{2}$

Q 17. A block of steel of size 5cm×5cm×5cm is weighed in water. If the relative density of steel is 7. Its apparent weight is :
(a) $6 \times 5 \times 5 \times 5$ gm-wt (b) $4 \times 4 \times 4 \times 7$ gm-wt
(c) $5 \times 5 \times 5 \times 7$ gm-wt (d) $4 \times 4 \times 4 \times 6$ gm-wt

Q 18. If a body floats with $\left(\frac{p}{q}\right)^{th}$ of its volume above the surface of the water, then the relative density of the body is :
(a) $\frac{q+p}{q}$ (b) $1-\frac{p}{q}$
(c) $\frac{p-q}{q}$ (d) $\frac{p}{q}$

Q 19. An object weighs 10N in air. When immersed fully in water, it weighs only 8N. The weight of the liquid displaced by the object will be:
(a) 2 N (b) 8 N
(c) 10 N (d) 12 N

Q 20. A sphere of solid material of relative density 9 has a concentric spherical cavity and just floats in water. If the radius of the sphere be R, then the radius of the cavity (r) will be related to R as:

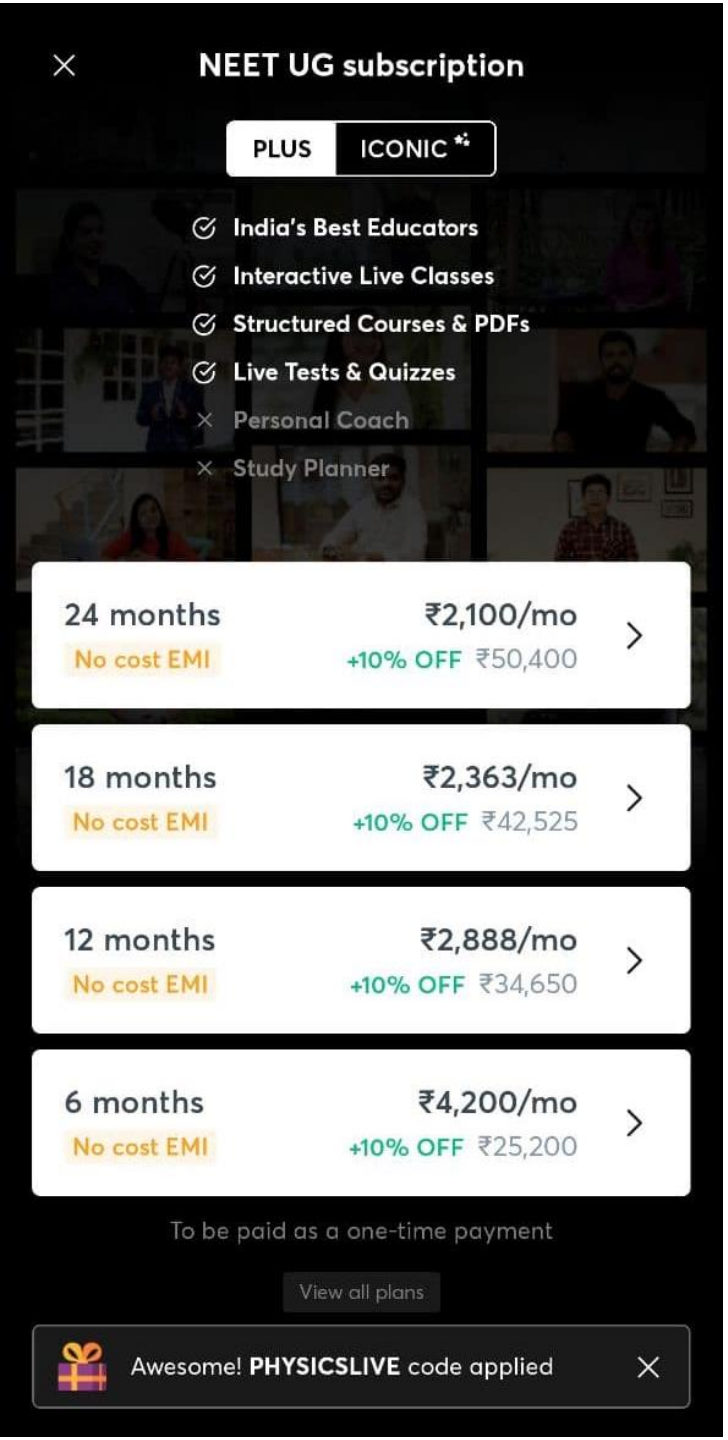
(a) $r^3 = \frac{8}{9}R^3$ (b) $r^3 = \frac{2}{3}R^3$

(c) $r^3 = \frac{\sqrt{8}}{3}R^3$ (d) $r^3 = \sqrt{\frac{2}{3}}R^3$

Answer Key

=

Q.1 d	**Q.2 c**	**Q.3 a**	**Q.4 d**	**Q.5 b**
Q.6 a	**Q.7 b**	**Q.8 d**	**Q.9 a**	**Q.10 d**
Q.11 d	**Q.12 d**	**Q.13 c**	**Q.14 c**	**Q.15 b**
Q.16 a	**Q.17 a**	**Q.18 b**	**Q.19 a**	**Q.20 a**



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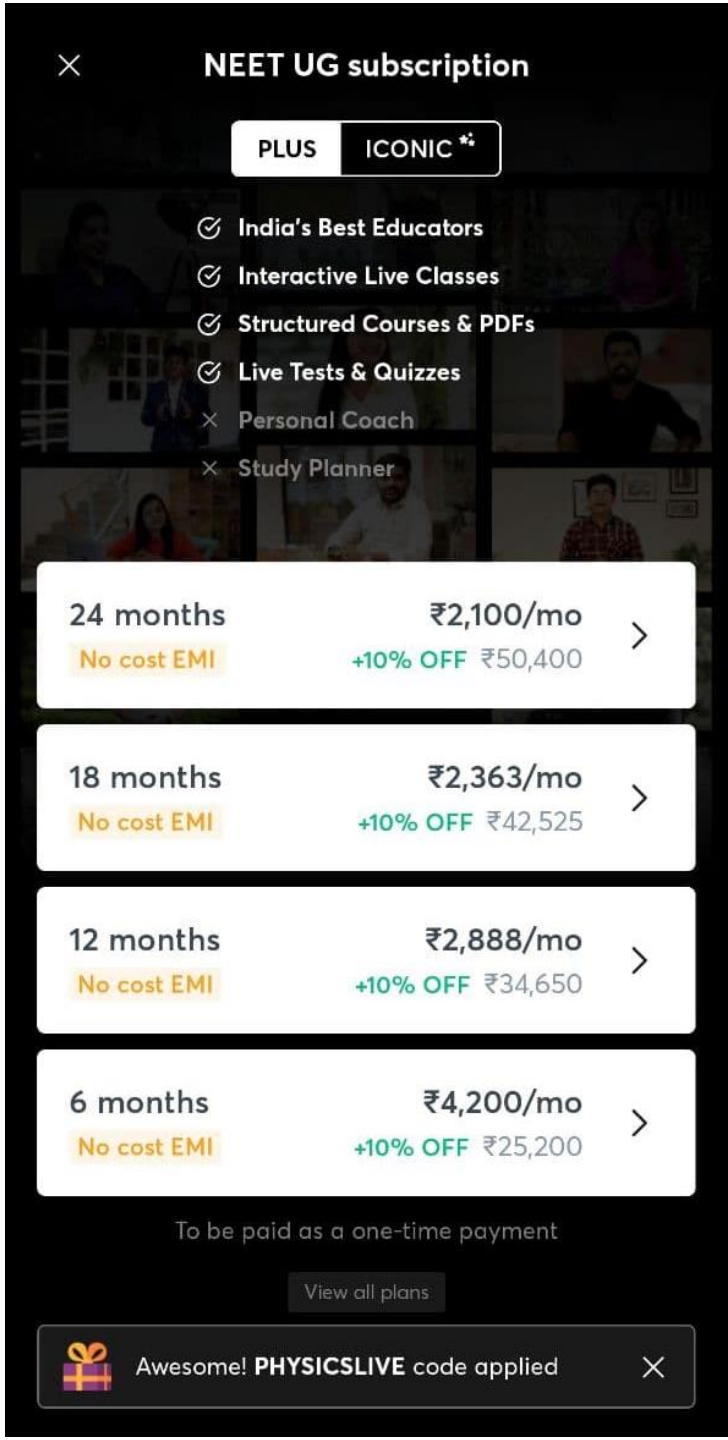
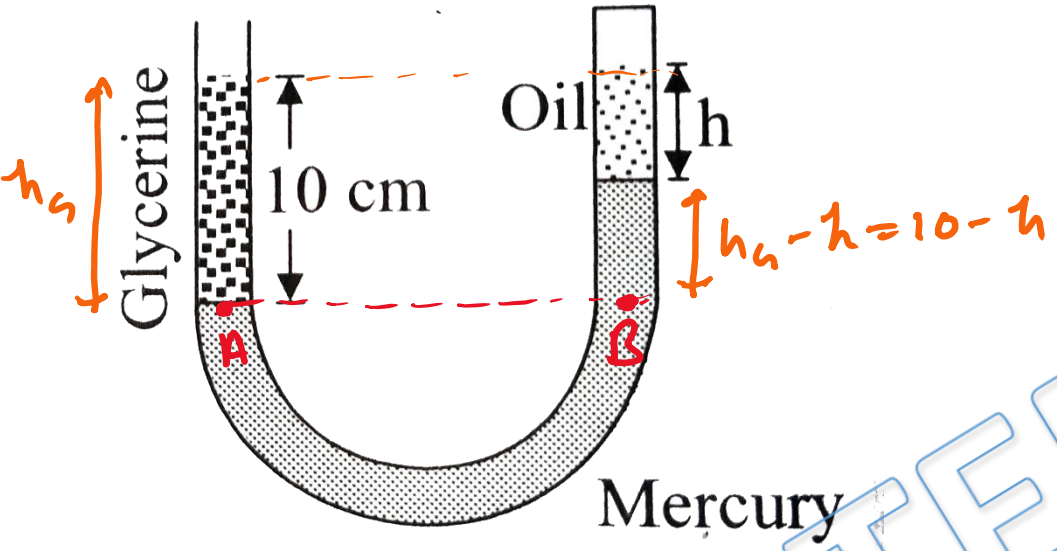


Written Solution

DPP-2 Fluid: Hydraulic Paradox, Pascal's Law, Archimedes' Principle

By Physicsaholics Team

Solution: 1



$P_A = P_B$

$\rho_g g h_g = \rho_o g h + \rho_m g (h_g - h)$

$1306 \times (10\,cm) = (806) \times h + 13606\,(10 - h)$

$130 = 8h + 1360 - 1360h$

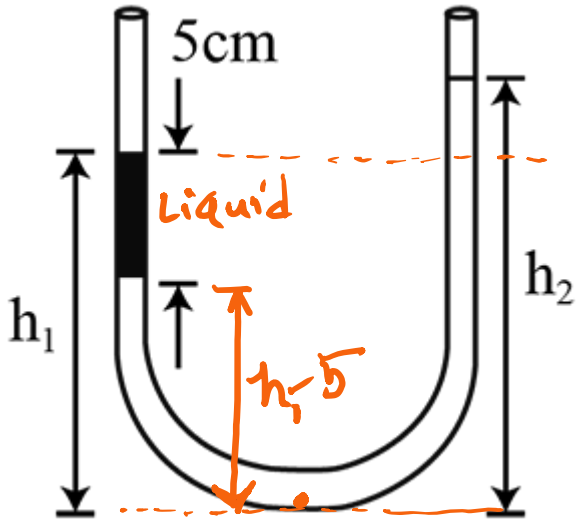
$1328\,h = 1230$

$h = \frac{1230}{1328}$

$h = 9.6\,cm$ Ans.

Ans. d

Solution: 2



$h_1 + h_2 = (20+20) + 5$

$h_1 + h_2 = 45\,cm$ — (i)

(i) + (ii) $\Rightarrow 2h_2 = 60\,cm$

$h_2 = 30\,cm$

$h_1 = 15\,cm$

$\rho_L g(5) + \rho_w g(h_1 - 5) = \rho_w g h_2$

$4 \times 5 + 1 \times (h_1 - 5) = 1 \times h_2$

$20 + h_1 - 5 = h_2$

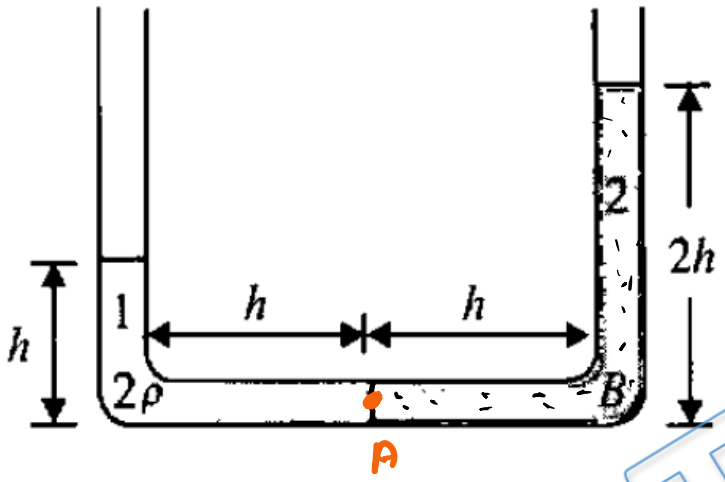
$h_2 - h_1 = 15\,cm$ — (ii)

$\Rightarrow \frac{h_2}{h_1} = \frac{30}{15}$

$\boxed{\frac{h_2}{h_1} = \frac{2}{1}}$ Ans.

Ans. c

Solution: 3



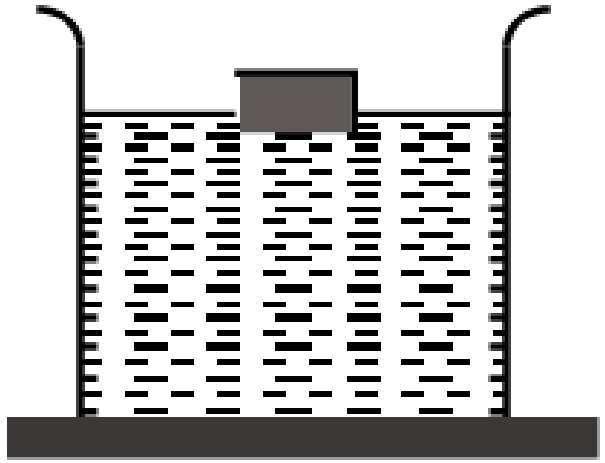
$P_A = P_A$

$(2\rho)\,g(h) = \rho_2\, g(2h)$

$\boxed{\rho_2 = \rho}$ Ans.

Ans. a

Solution: 4



$$V = a^3 = \frac{4m}{3\rho}$$

$$\boxed{a = \left(\frac{4m}{3\rho}\right)^{1/3}} \quad \text{Ans.}$$

$$mg = \left(\frac{3}{4}V\right)\rho g$$

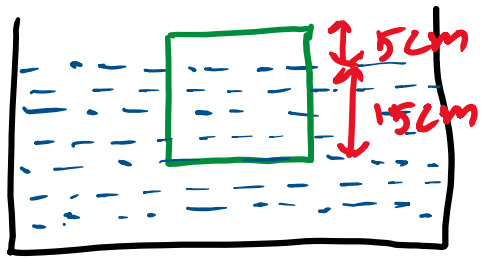
$$\frac{3}{4}V = \frac{m}{\rho}$$

$$V = \frac{4m}{3\rho}$$

Ans. d

Solution: 5

$V = a^3 = (0.2)^3\ m^3$ or $(20)^3\ cm^3$



Let Volume immersed in liquid $= V_L$

So, $V_L = (20)^2 \times 15\ cm^3$

Cross-section area $= A = (0.2)^2$

$mg = \rho_w V_L g$

$m = (0.8\ gm/cc) \times (20^2 \times 15)$

$m = 0.8 \times 400 \times 15$

$= 320 \times 15$

$m = 4800\ gm$

$\boxed{m = 4.8\ kg}$ Ans

Ans. b

Solution: 6

Liquid : 1

$\rho V g = \rho_1 V g$

$\rho_1 = \rho$

Liquid : 2

$\rho V g = \rho_2 V_i g$

$\rho (4\times10^{-2})^3 g = \rho_2 ((4\times10^{-2})^2 \times (2\times10^{-2})) g$

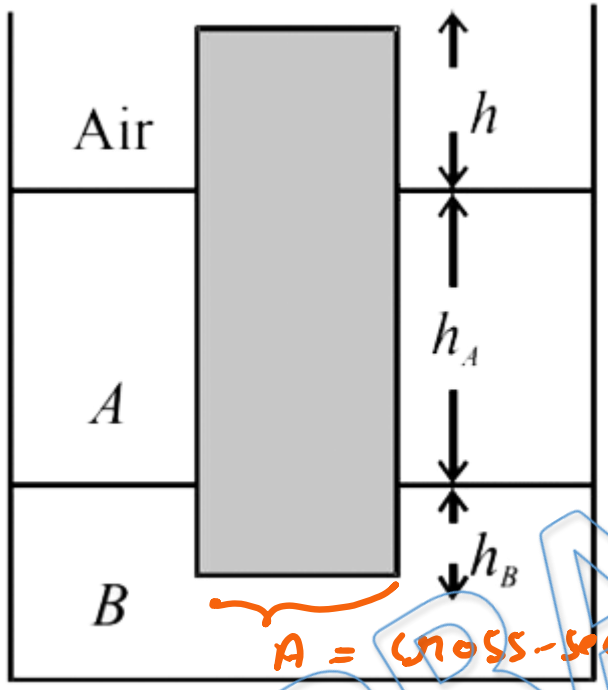
$64\rho = \rho_2 (32)$

$\rho_2 = 2\rho$

$\Rightarrow \frac{\rho_1}{\rho_2} = \frac{1}{2}$ Ans

Ans. a

Solution: 7



A = cross-section Area

$$(0.8)(h + 1.2 + 0.8) = (0.7)(1.2) + (1.2)(0.8)$$

$$h + 2 = \frac{0.7 \times 1.2}{0.8} + \frac{1.2 \times 0.8}{0.8}$$

$$h + 2 = 1.05 + 1.2$$

$$h + 2 = 2.25 \text{ cm}$$

$$\boxed{h = 0.25 \text{ cm}}$$ Ans.

$$mg = f_A + f_B$$

$$\rho [A \times (h_A + h_B + h)] g = \rho_A [A \times h_A] g + \rho_B [A \times h_B] \times g$$

$$\rho (h + h_A + h_B) = \rho_A h_A + \rho_B h_B$$

Ans. b

Solution: 8

water:

$\rho_w = 1\ g/cm^3$

$\Rightarrow$ Let Volume of block $= V$

& density $= \rho$

then $\rho V g = \rho_w \left(\frac{V}{2}\right) g$ — (1)

for liquid of $\rho_l = 0.5\ g/cm^3$

$\rho V g = \rho_l V_d g$ — (2)

Let V_d = dipped volume

from eq^n (1) & (2)

$\rho_w \left(\frac{V}{2}\right) g = \rho_l V_d g$

$\Rightarrow 1 \left(\frac{V}{2}\right) g = 0.5 (V_d) g$

$\boxed{V_d = V}$

100% of its volume should be immersed in a liquid of density 0.5 g/cm^3.

Ans

Ans. d

Solution: 9

Volume of wood

$$V = \frac{m}{\rho} = \frac{120}{600}$$

$$\boxed{V = \frac{1}{5}\ m^3}$$

» Let mass m is required to sink the wood log

Then;

$$mg + \rho V g = \rho_w V g$$

$$m = \rho_w V - \rho V$$

$$= (\rho_w - \rho) V$$

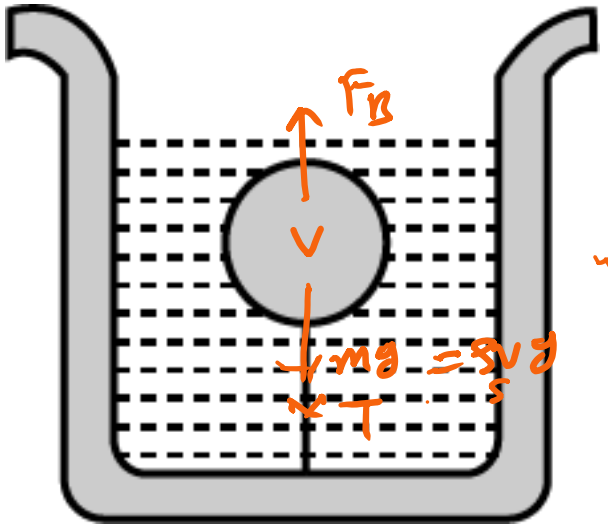
$$= (1000 - 600) \times \frac{1}{5}$$

$$= 400 \times \frac{1}{5}$$

$$\boxed{m = 80\ kg}$$ Ans.

Ans. a

Solution: 10



$\rho_s Vg = mg$

$\rho_s Vg + T = \rho_\omega Vg$

$T = (\rho_\omega - \rho_s) Vg$

let density of water $= \rho_\omega$

then density of sphere $= \rho_s = \frac{\rho_\omega}{n} \Rightarrow \rho_\omega = n\rho_s$

[∵ given that density of sphere is n time lighter than density of water]

$T = (n\rho_s - \rho_s) Vg$

$T = (n-1)(\rho_s Vg)$

$T = (n-1)\, mg$ Ans.

Ans. d

Solution: 11

$$P_1 = P_2$$

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$\frac{2}{10\,\text{cm}^2} = \frac{F_2}{100\,\text{cm}^2}$$

$$F_2 = 2 \times 10$$

$$\boxed{F_2 = 20\,N}$$ Ans.

Ans. d

Solution: 12

Pressure will be same on both pistons

So; $P = \frac{F_2}{A_2} = \frac{F_1}{A_1}$

$P = \frac{3000 \times 10}{5 \times 10^{-2}}$

$P = 6 \times 10^5 \ N/m^2$ Ans.

Ans. d

Solution: 13

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$\frac{2000 \times 10}{300\ cm^2} = \frac{F_2}{10\ cm^2}$$

$$F_2 = \frac{2000}{9}\ N$$

$$\boxed{F_2 = 222.2\ N}$$ Ans.

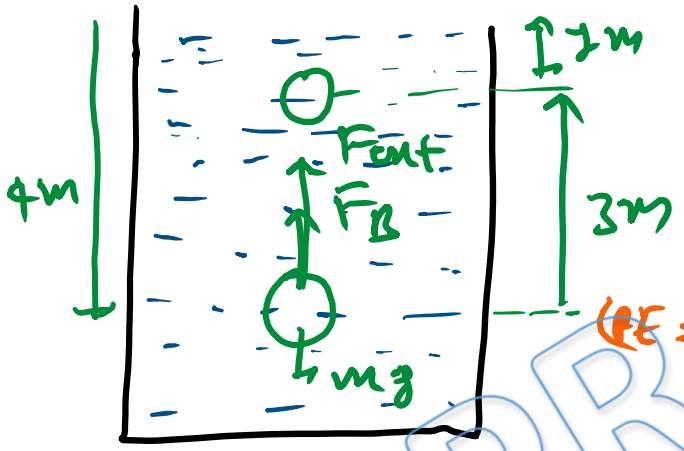
Ans. c

Solution: 14

density of water = 1000 kg/m³

relative density of stone = 2

⇒ density of stone = 2 × 1000 = 2000 kg/m³



$(PE+KE)_i + W_{ext} + W_{F_B} = (PE+KE)_f$

$0 + 0 + W_{ext} + (30 \times 3) = mgh + 0$

$W_{ext} + 90 = 6 \times 10 \times 3$

$W_{ext} = 180 - 90$

$\boxed{W_{ext} = 90\ J}$ Ans

$F_B = \rho_w V g$

$V = \frac{\text{mass}}{\text{density of stone}} = \frac{6}{2000}\ m^3$

$F_B = 100 \times \frac{6}{2000} \times 10 = 30\ N$

Ans. c

Solution: 15

Buoyant Force $= V\rho g$
where V= Volume of object submerged
ρ= Density of liquid in which object is submerged
g= acceleration due to gravity
Hence buoyant force depends on density of liquid.

Ans. b

Solution: 16

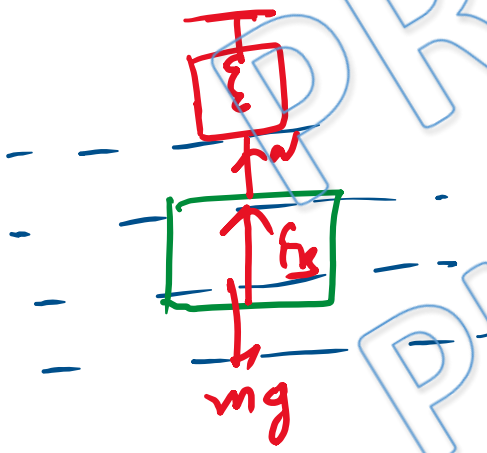
mass of block $= \frac{60}{10} = 6\,kg$

Let sp. density of block is $= n$

density of water $= 1000\ kg/m^3$

then density of block $= 1000n\ kg/m^3$

Volume of block $= \frac{mass}{density} = \frac{6}{1000n}$



reading of Sp. balance $= N = 40\,N$

$\Rightarrow N + F_B = mg$

$40 + \frac{6}{1000n} \times 1000 \times 10 = 60$

$\frac{60}{n} = 20$

$n = 3$ Ans.

Ans. a

Solution: 17

Vol. $= V = 5 \times 5 \times 5 \ cm^3$

density of water $= 1 \ gm/cm^3$

density of steel $= 7 \times 1 = 7 \ gm/cm^3$

App. wt $=$ $mg - F_B$ [ρ & V are in cgs]

so; [Put value of g will be in cgs]

$= \rho V g - \rho_w V g$

$= (\rho - \rho_w) V g$

$= (7 - 1)(5 \times 5 \times 5) g$

$= (6 \times 5 \times 5 \times 5 \ gm) g$

App. wt $= 6 \times 5 \times 5 \times 5$ gm-wt

Ans. a

Solution: 18

Let; Volume of body = V

(V_L) volume immersed in Liquid = $V - \frac{\rho V}{\sigma} = V\left(\frac{\sigma-\rho}{\sigma}\right)$

relative density = $\frac{\rho}{\rho_w}$

$$\frac{\rho}{\rho_w} = 1 - \frac{\rho}{\sigma} \quad \text{Ans.}$$

$$\rho V g = \rho_w V_L g$$

$$\frac{\rho}{\rho_w} = \frac{V_L}{V}$$

$$\frac{\rho}{\rho_w} = \frac{V\left(\frac{\sigma-\rho}{\sigma}\right)}{V}$$

$$\frac{\rho}{\rho_w} = \frac{\sigma-\rho}{\sigma} \quad \text{Ans.}$$

Ans. b

Solution: 19

Given, Weight of an object in air =10N, Weight of this object in water =8N

So, the weight of the liquid displaced by the object F= 10-8=2N and we know that according to Archimedes' Principle, buoyancy force = weight of the liquid displaced by the body.

Ans. a

Solution: 20

density of water = $\rho_w = \rho$

density of sphere = $\rho_s = 9\rho$

$$mg = \rho_w V g$$

$$\rho_s\left(\frac{1}{3}\pi(R^3 - r^3)\right)g = \rho_w\left(\frac{4}{3}\pi R^3\right)g$$

$$\rho_s(R^3 - r^3) = \rho_w(R^3)$$

$$9\rho(R^3 - r^3) = \rho R^3$$

$$9R^3 - 9r^3 = R^3$$

$$9r^3 = 8R^3$$

$$\boxed{r^3 = \frac{8R^3}{9}}$$ Ans.

Ans. a

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