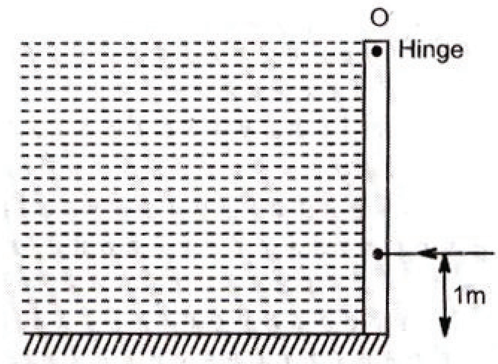
PHYSICS **Max. Marks: 61**

SECTION – I

(SINGLE CORRECT CHOICE TYPE)

This section contains **7 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE is correct. Marking scheme +3 for correct answer , 0 if not attempted and -1 in all other cases.**

1. A square gate of size $4m \times 4m$ is hinged at topmost point. A fluid of density ρ fills the space left of it. The force which acting 1m from lowest point can hold the gate stationary is:



A) $\frac{256}{3}\rho g$ **B)** $\frac{256}{9}\rho g$ **C)** $\frac{128}{9}\rho g$ **D)** $\frac{128}{3}\rho g$

2. Two cylinders of same cross section area and length L but made of two materials of densities d_1 and d_2 are connected together to form a cylinder of length 2L. The combination floats in a liquid of density d with a length L/2 above the surface of the liquid. If $d_1 > d_2$ then

A) $d_1 > \frac{3}{4}d$ **B)** $\frac{d}{2} > d_1$ **C)** $\frac{d}{4} > d_1$ **D)** $d < d_1$

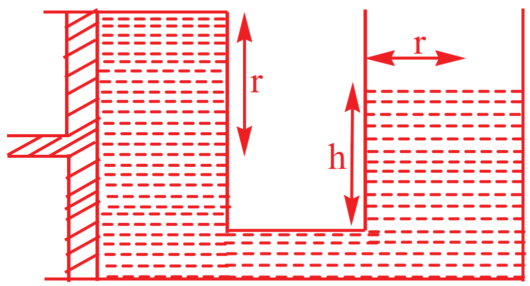
3. To what height (h) should a cylindrical vessel of radius (R) be filled with a homogeneous liquid to make the force with which the liquid presses on the curved side wall of the vessel equal to the force exerted by the liquid on the bottom of the vessel ?

A) $h = R$ **B)** $h = \sqrt{2}R$ **C)** $h = \frac{R}{2}$ **D)** $h = 2R$

4. A U-tube in which the cross sectional area of the left limb is one quarter that of the right limb. The tube contains mercury $\left(density(\rho)=13.6gm/cc\right)$. The level of mercury in the narrow limb is at a distance of 36 cm from the upper end of the tube. What will be the rise in the level of mercury in the right limb if the left limb is filled to the top with water?

A)1.2cm **B)**2.35cm **C)**0.56cm **D)**0.8cm

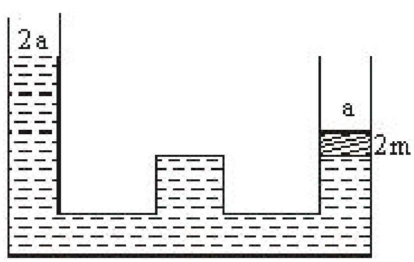
5. Two cylinders with a horizontal and vertical axis respectively rest on a horizontal surface. The cylinders are connected at the lower parts through a thin tube.



The horizontal cylinder (radius 'r') is open at one end and has a piston in it as shown in the figure. The vertical cylinder is open at the top. The cylinders contain water which completely fills the part of the horizontal cylinder behind the piston and is at a certain level in the vertical cylinder (Neglect the friction). Determine the level 'h' of water in the vertical cylinder at which the piston is in equilibrium.

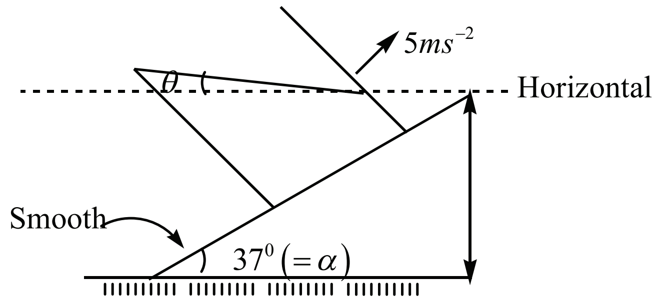
A)r **B)**2r **C)**r/2 **D)**r/3

6. In the adjoining figure the cross sectional area of smaller tube is a and the adjacent tube is 2a. A block of mass 2 m is kept in the smaller tube have same base area a as that of the tube. The difference between water levels of the two tubes are (density of water $=\rho$.)



A) $\frac{p_0}{\rho g}+\frac{m}{a\rho}$ **B)** $\frac{p_0}{\rho g}+\frac{m}{2a\rho}$ **C)** $\frac{2m}{a\rho}$ **D)** $\frac{m}{a\rho}$

7. On a smooth inclined plane (with angle of inclination $\alpha = 37^0$), a vessel containing liquid is being pushed upwards with an acceleration $5\ ms^{-2}$. If g=10 ms^{-2}, then angle (θ) that liquid surface makes with the horizontal is (Given $\sin 37^0 = \frac{3}{5}$)



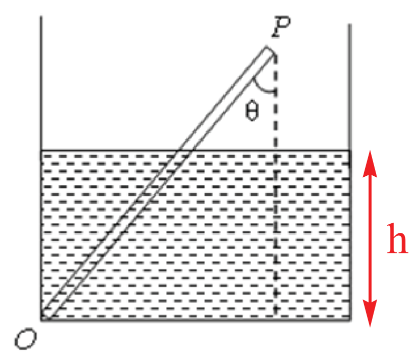
A) 37^0 **B)** 53^0 **C)** $\tan^{-1}\left(\frac{4}{13}\right)$ **D)** $\tan^{-1}\left(\frac{5}{13}\right)$

SECTION-II

(ONE OR MORE OPTIONS CORRECT TYPE)

This section contains 7 multiple choice equations. Each question has four choices **(A)** **(B)**,**(C)** and **(D)** out of which **ONE** or **MORE THAN ONE** are correct. **Marking scheme: +4 for all correct options & +1 partial marks, 0 if not attempted and -2 in all wrong cases**

8. A wooden plank OP of length 1m and uniform cross-section s is hinged at one end to the bottom of a tank. The tank is filled with water up to a height h m. The specific gravity ρ_s of the plank is 0.5. In the equillibrium position, the plank makes an angle θ with the vertical as shown in figure. Then, if $\theta = 45^0$,



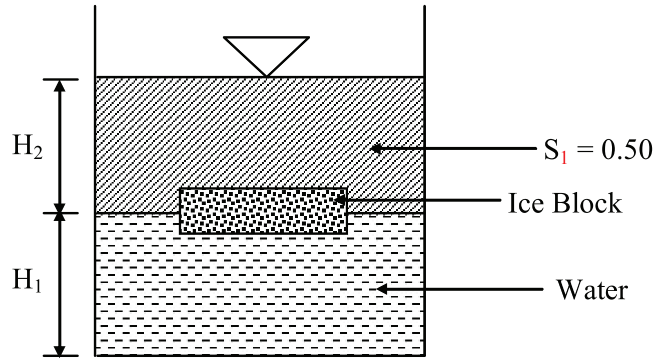
A) the value of h is 0.5 m.

B) horizontal component of reaction at O is zero.

C) Centre of buoyancy would get shifted if ρ_s is altered

D) location of centre of buoyancy is proportional to $\left(\frac{\rho_s}{\rho_\ell}\right)$

9. A block of ice (specific gravity $S_i = 0.90$) is floating in a container having two immiscible liquids (one of specific gravity $S_1 = 0.50$ and other is water) as shown in the figure. (H_1, H_2 are heights of water, other liquid columns respectively). Now the ice block melts completely, then



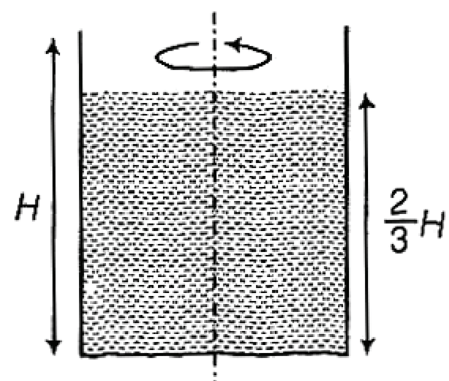
A) H_2 will decrease

B) H_1 will increase

C)H_1 will remains unchanged,where as H_2will decrease

D)Both $H_1$and H_2will increase

10. A circular cylinder of radius R and height H is filled with water to a height $\frac{2}{3}H$. It starts rotating about its axis with constantly increasing angular speed. Choose the correct statement(s)



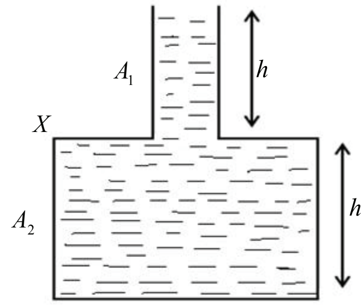
A) At all speeds, shape of the free surface is paraboloid

B) The free surface touches first the brim of the cylinder and then the base of the cylinder

C) The free surface can not touch the base without spilling water

D) The free surface touches the brim as well as the base at the same instant

11. The vessel shown in figure has two sections of area of cross section A_1,and A_2. A liquid of density ρ fills both the sections,upto height h in each. Neglect the atomospheric pressure ,



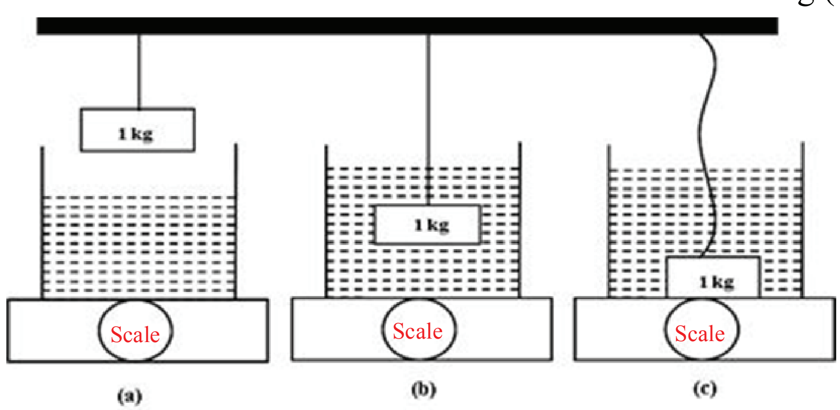
A) The pressure at the base of the vessel is 2 ρ gh

B) The weight of the liquid in vessel is equal to 2 ρ gh

C) The force exerted by the liquid on the base of vessel is 2 ρ gh A_2

D) The walls of the vessel at the level X exert a force ρ gh($A_2 - A_1$) downwards on the liquid.

12. Three identical blocks each of mass $m = 1$kg and volume $3\times10^{-4}\ m^3$ are suspended by mass less strings from a support as shown. Underneath are three identical containers containing same amount of water are placed over the scales. In Fig.(a) the block is completely out of the water, in Fig. (b) the block is completely submerged but not touching the beaker, and in Fig(c). the block rests on the bottom of the beaker. The scale in Fig.(a) reads 14 N



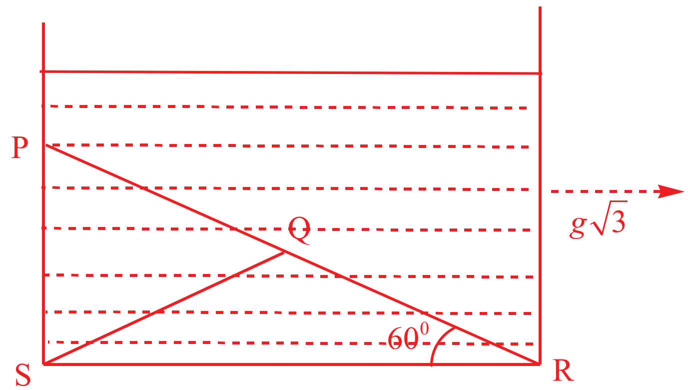
A) The tension in the string in (b) is 10 N.

B) The tension in the string in (b) is 7 N.

C) The reading of the scale in (b) is 17 N.

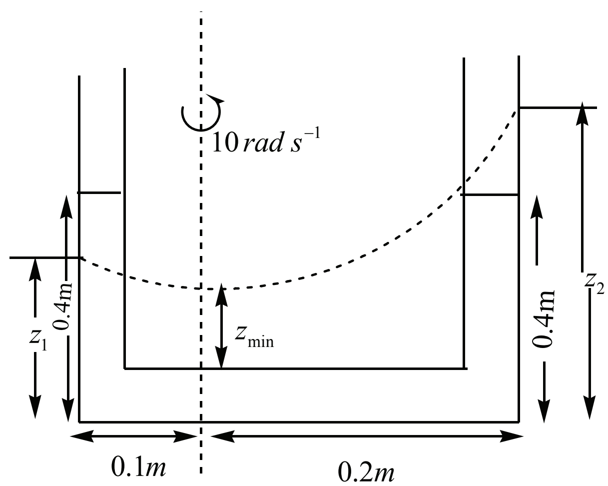
D) The reading of the scale in (b) is 24 N.

13. A vessel contains water, PQR and SQ are imaginary lines and they are on the same plane.Which is the plane of the figure.Q is the middle point of PR.Now, the vessel moves rightwards with a constant acceleration $g\sqrt{3}$ .Then, choose the correct statement(s)



A) If one moves from S to Q to R, pressure first decreases and later remains constant
B) If one moves from P to Q to S, pressure first constant and later increase
C) If one moves from P to Q to R, pressure remains constant
D) If one moves from R to Q to S, pressure first decreases and then increases.

14. An upright narrow U-tube manometer with its limbs 0.6 m high and spaced 0.3 m apart contains a liquid to a height of 0.4 m in each limb. The U tube is rotated at 10 $rad\,s^{-1}$ about a vertical axis at 0.1 m from one limb. Then, (Given $g = 10ms^{-2}$)



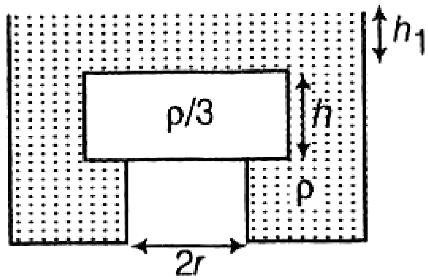
A) $\frac{z_1}{z_2} = 0.684$ **B)** $\frac{z_1}{z_2} = 0.513$ **C)** $z_{min} = 0.275m$ **D)** $z_{min} = 0.1375m$

SECTION – III
(PARAGRAPH TYPE)

This section contains **2 groups of questions.** Each group has 2 multiple choice questions based on a paragraph. Each question has 4 choices A), B), C) and D) for its answer, out of which **ONLY ONE** is **correct.Marking scheme: +3 for correct answer, 0 if not attempted and 0 in all other cases.**

Passage – 1:

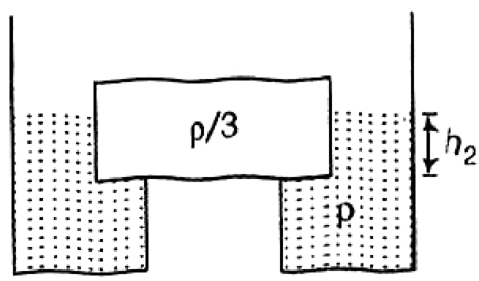
A wooden cylinder of diameter 4r, height h and density $\rho/3$ is kept on a hole of diameter 2r of a tank, filled with liquid of density ρ as shown in the figure.



15. Now level of the liquid starts decreasing slowly. When the level of liquid is at a height h_1 Above the cylinder, the block starts moving up. At what value of h_1, will the block rise ?

A) 4h / 9 **B)** 5h / 9 **C)** $\frac{5h}{3}$ **D)** Remains same

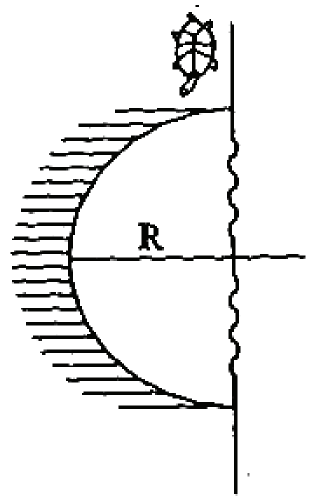
16. The block in the above question is maintained at the position by external means and the level of liquid is lowered. The height h_2 when this external force reduces to zero, is



A) $\frac{4h}{9}$ **B)** $\frac{5h}{9}$ **C)** Remains same **D)** $\frac{2h}{3}$

PASSAGE-2

A tortoise is just sinking in water of density ρ. The tortoise is assumed to be a hemisphere of radius R. Neglect atmospheric pressure



17. Find the vertical thrust

A) $\rho g \pi R^3$ **B)** $\frac{1}{3}\rho g \pi R^3$ **C)** $\frac{2}{3}\rho g \pi R^3$ **D)** 0

18. Find the total hydrostatic force

A) $\rho g \pi R^3$ **B)** $\sqrt{\frac{13}{3}}\rho g \pi R^3$ **C)** $\frac{2}{3}\rho g \pi R^3$ **D)** $\sqrt{\frac{16}{3}}\rho g \pi R^3$

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Sec: Sri Chaitanya-Jr.Chaina-1 Jee-Adv(2017_P2) Date: 11-11-18

Time: 3 Hr's **WTA - 17** Max. Marks: 183

KEY & SOLUTIONS

PHYSICS:-

1	B	**2**	A	**3**	A	**4**	C	**5**	A	**6**	C
7	C	**8**	ABC	**9**	AB	**10**	ABC	**11**	ACD	**12**	BCD
13	ABC	**14**	AC	**15**	C	**16**	A	**17**	C	**18**	B

CHEMISTRY:-

19	C	**20**	A	**21**	B	**22**	B	**23**	C	**24**	B
25	D	**26**	AD	**27**	ABC	**28**	ABCD	**29**	ABC	**30**	ABC
31	ABD	**32**	ACD	**33**	D	**34**	B	**35**	A	**36**	B

MATHS:-

37	B	**38**	D	**39**	A	**40**	A	**41**	C	**42**	C
43	A	**44**	BD	**45**	ABD	**46**	BD	**47**	ABCD	**48**	BD
49	AC	**50**	ABCD	**51**	A	**52**	D	**53**	A	**54**	D

SOLUTIONS

PHYSICS

1. $\tau_{netwings} = 0 \quad \left[fgxdxw\right]x = F\left(3\right) \; F = \frac{\left[\delta gwx^3\right]_0^L}{9} \quad = \frac{\delta gwL^3}{9} \quad = \frac{256}{9}\delta g$

2. $U = mg \Rightarrow dA\frac{L}{2}g = d_1ALg + d_2ALg$

3. Force on the side wall is F_1 = Average pressure X curved surface area

   Or $F_1 = \left(\frac{\rho gh}{2}\right)\left(2\pi Rh\right) = \pi R\rho gh^2\left(\rho = density\ of\ liquid\right)$

   Force on the bottom is F_2 = Pressure at the bottom X area of the bottom

   $\left(\rho gh\right)\left(\pi R^2\right) = \pi\rho ghR^2$ Given, $F_1 = F_2$ $\quad \therefore \pi R\rho gh^2 = \pi\rho ghR^2 \Rightarrow h = R$

4. $\delta_w gx = \delta_{Hg}g\left(x + \frac{x}{4}\right) \quad x = 0.56cm$

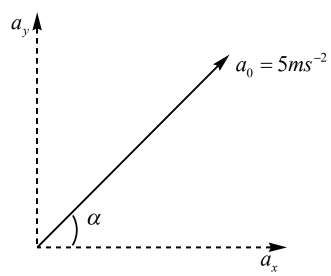
5. A Net force on position of horizontal cylinder = zero

   $\left(P_0 + \rho gh - \rho gr\right)\pi r^2 = P_0\pi r^2 \qquad h = r$

6. Using Parcals law at the bottom of two tubes $P_0 + \frac{2mg}{a} + \rho gh_1 = \rho g\left(h_1 + \Delta h\right) + P_0$

   Solving $\Delta h = \frac{m}{a\rho}$.

7. $a_x = a_0\cos\alpha = 5\cos 37^0 = 4ms^{-2} \qquad a_y = a_0\sin\alpha = 5\sin 37^0 = 3ms^{-2}$



   $\theta = \tan^{-1}\left(\frac{a_x}{a_y + g}\right) = \tan^{-1}\left(\frac{4}{3+10}\right) = \tan^{-1}\left(\frac{4}{13}\right)$

8. The situation is shown in the figure. The upthrust F_B acts through G. G is the centre of gravity. The reaction R acts through O. Let the length of the rod inside water be ℓ'.

   Taking moments about O,

   $F_B \times a' = mg \times a \qquad a = \left(\frac{\ell}{2}\right)\sin\theta \therefore \ell' = \ell\sqrt{\frac{\rho_s}{\rho_\ell}} = 1\times\sqrt{0.5}$

   also $\cos\theta = \frac{h}{\ell'} \therefore h = \ell'\cos\theta = \ell'\cos 45^0$

   $-1\times\sqrt{0.5}\times\frac{1}{\sqrt{2}} - \frac{1}{2}m \therefore = 0.5m$

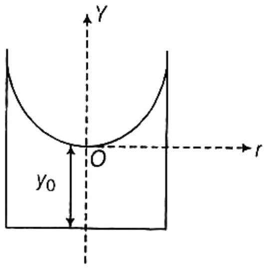
   If ρ_s is changed, location $(OG = \ell')$ of the centre of buoyancy gets shifted.

   Further $\ell' \propto \sqrt{\frac{\rho_s}{\rho_\ell}}$

9. (A), (B)

   H_2 will decrease because water formed by ice will merge with water. H_1 will increase

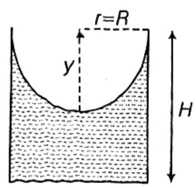
10. Equation of free surface is $y = \dfrac{\omega^2 r^2}{2g}$



If a parabola y = kx^2 is rotated about Y – axis, the volume of the paraboloid formed is $V = \dfrac{\pi}{2k} y^2$.

Let us assume free surface first touches the brim. When free surface first touches the brim r = R

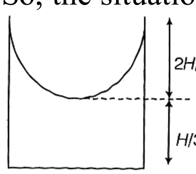
Volume of paraboloid is $V = \dfrac{\pi}{2\left(\dfrac{\omega^2}{2g}\right)} y^2 = \dfrac{g\pi}{\omega^2}.y^2$ Initial volume of water = Final volume of



water $\therefore \pi R^2.\dfrac{2}{3}H = \pi R^2 H - \dfrac{g}{\omega^2}.\pi y^2$ $\Rightarrow \dfrac{g}{\omega^2} y^2 = \dfrac{1}{3} HR^2$ or $\dfrac{\omega^2}{g} = \left(\dfrac{3}{HR^2}\right) y^2$

Now, $y = \dfrac{\omega^2 r^2}{2g}$ $\Rightarrow y = \dfrac{1}{2}\left(\dfrac{3}{HR^2}\right) y^2.R^2$ or $y = \dfrac{2H}{3}$

So, the situation (where, r = R) becomes as shown in the figure



For the free surface to touch the base, ω has to be further increased and water has to spill out.

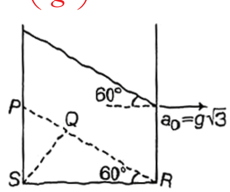
11. Conceptual

12. Density of block $= \dfrac{1}{3\times10^{-4}} kg/m^3 = \dfrac{10}{3}\times10^3\ kg/m^3$

Buoyant force $B = 3\times10^{-4}\times10^3\times g = 3N$ $\therefore$ $T_B = 10\ \ 3 = 7N$

Reading of $B = 14 + 3 = 17N$ Reading of $C = \{14 + (10-3)03\} N - 24N$

13. If a_0 is the horizontal acceleration of the vessel, then the water surface makes an angle $\theta = \tan^{-1}\left(\dfrac{a_0}{g}\right)$ with the horizontal.



$\therefore \theta = \tan^{-1}\left(\dfrac{g\sqrt{3}}{g}\right) = \tan^{-1}\left(\sqrt{3}\right) = 60^0$

So, in the accelerating container, free surface of water is parallel to PQR. So, pressure at every point on the PQR will be same. And as one moves from Q to S, pressure increases.

14. Let Z_{min} is the minimum level of the dotted parabola

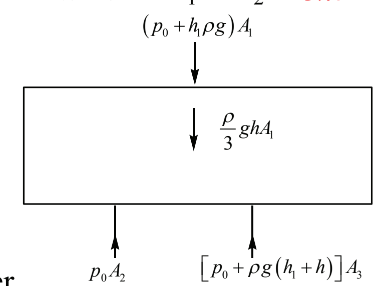
$\therefore Z_1 = Z_{\min} + \frac{r_1^2\omega^2}{2g} = Z_{\min} + \frac{(0.1)^2(10)^2}{2\times10}$ And $\therefore Z_2 = Z_{\min} + \frac{r_2^2\omega^2}{2g} = Z_{\min} + \frac{(0.2)^2(10)^2}{2\times10}$

But $Z_1 + Z_2 = 2\times0.4 = 0.8m$ Solving the above equations, we get

$Z_{\min} = 0.275$ m $\therefore Z_1 = 0.275 + \frac{(0.1)^2(10)^2}{2\times10} = 0.325m$

$\therefore Z_2 = 0.275 + \frac{(0.2)^2(10)^2}{2\times10} = 0.475m$ So, $\frac{Z_1}{Z_2} = \frac{0.325}{0.475} = 0.684$

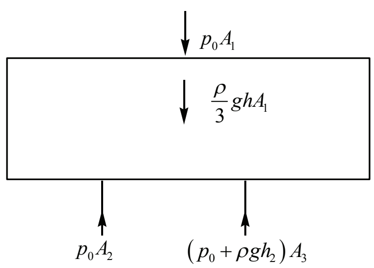
15. Let A_1 = Area of cross – section of cylinder = $4\pi r^2$ A_2 = Area of base of cylinder in air = πr^2
And A_3 = Area of base of cylinder in water = $A_1 - A_2$ = $3\pi r^2$



The free body diagram of cylinder

Equating the net downward forces and net upward forces, we get, $h_1 = \frac{5}{3}h$.

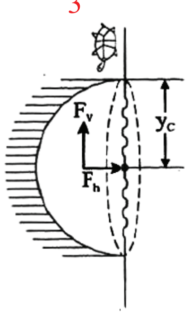
16. Again equating the forces, we get $h_2 = \frac{4h}{9}$



17. Let the horizontal and vertical thrusts on the tortoise be F_h and F_v, respectively.
We know that $F_h = \rho g y_c A_y$ where $y_c = R$ and $A_v = \pi R^2$. This gives $F_h = \rho g\pi R^3$ towards right

Similarly using the formula $F_v = \rho V g$ where V = volume of the tortoise = $\frac{2}{3}\pi R^3$ we have

$F_v = \frac{2}{3}\rho g\pi R^3 (up)$



18. Hence the net hydrostatic force on the tortoise is

$$F = \sqrt{F_h^2 + F_v^2} = \sqrt{(\rho g\pi R^3)^2 + \left(\frac{2}{3}\rho g\pi R^3\right)^2} = \sqrt{\frac{13}{3}}\rho g\pi R^3$$

Final Key

S.NO	SUB	Q.NO	GIVEN KEY	FINAL KEY	REMARKS
1	PHY	12	BCD	BC	In option D the reading of scale in (b) is 17N not 24N
2	PHY	18	B	DELETE	The correct answer is $\frac{\sqrt{13}}{3}\rho m R^3$ clear