Q-1 - 11748742

Two wires A and B are of same material. Their lengths are in the ratio 1:2 and diameters are in the ratio 2:1 when stretched byb force F_A and F_B respectively they get equal increase in their lengths. Then the ratio $\frac{F_A}{F_B}$ should be

(A) $1:2$

(B) $1:1$

(C) $2:1$

(D) $8:1$

CORRECT ANSWER: D

SOLUTION:

$$F = Y \times A \times \frac{l}{L} \Rightarrow F \propto \frac{r^2}{L}$$

$$\frac{F_A}{F_B} = \left(\frac{r_A}{r_B}\right)^2 \times \left(\frac{L_B}{L_A}\right) = \left(\frac{2}{1}\right)^2 \times \left(\frac{2}{1}\right) = \frac{8}{1}$$

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Q-2 - 10964759

Assertion : steel is more elastic than rubber.

Reason : For same strain , steel requires more stress to be produced in it.

(A) (a) If both Assertion and Reason are true and the Reason is correctn explanation of the Assertion.

(B) (b) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(C) If Assertion is true, but the Reason is false.

(D) If Assertion is false but the Reason is true.

CORRECT ANSWER: A

Q-3 - 11748784

The pressure applied from all direction on a cube is P. How much its temperature should be raised to maintain the original volume ? The volume elasticity of the cube is β and the coefficient of volume expansion is α

(A) $\frac{P}{\alpha\beta}$

(B) $\frac{P\alpha}{\beta}$

(C) $\frac{P\beta}{\alpha}$

(D) $\frac{\alpha\beta}{P}$

CORRECT ANSWER: A

SOLUTION:

If coefficient of volume expansion is α and rise in

temperature is $\triangle\theta$ then

$$\triangle V = V\alpha\triangle\theta$$

$$\Rightarrow \frac{\triangle V}{V} = \alpha\triangle\theta$$

Volume elasticity

$$\beta = \frac{P}{\frac{\triangle V}{V}} = \frac{P}{\alpha\triangle\theta}$$

$$\Rightarrow \triangle\theta = \frac{P}{\alpha\beta}$$

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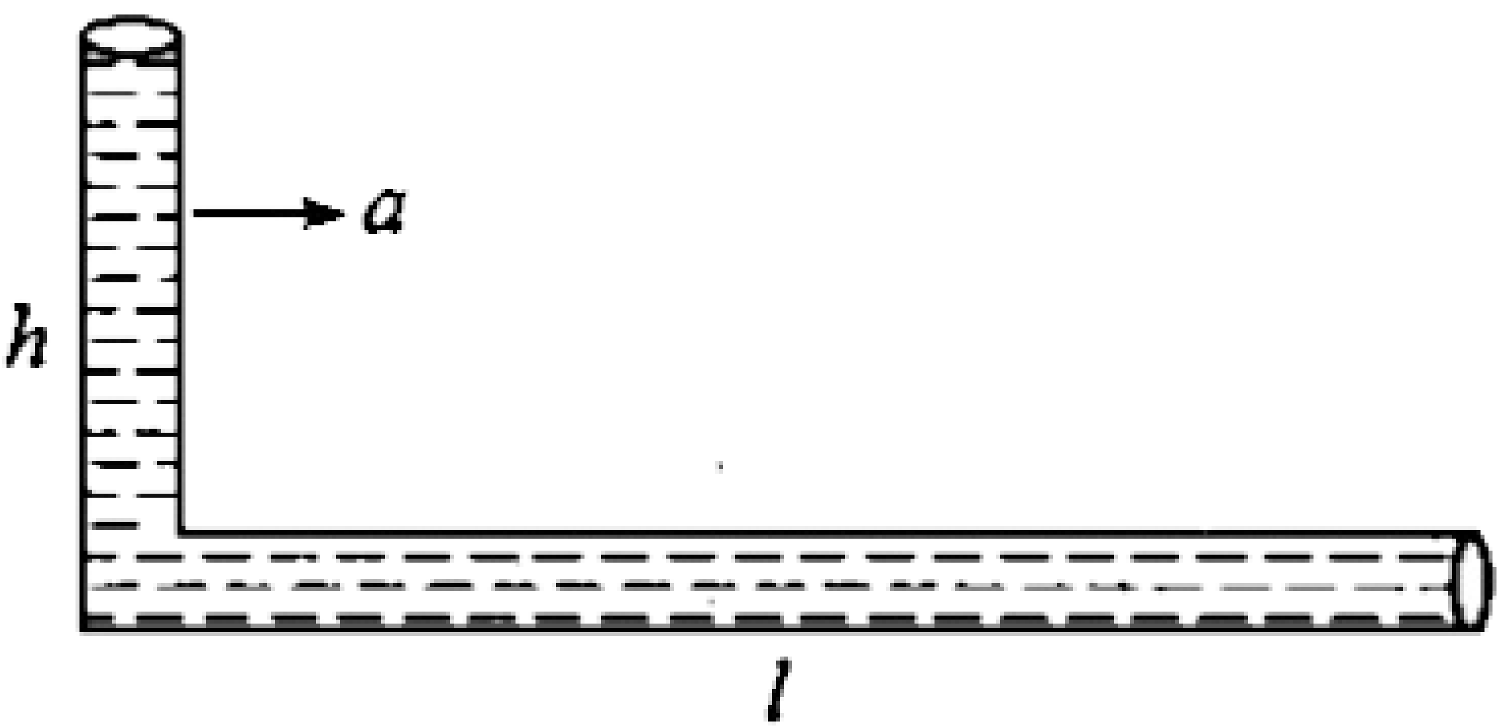
Q-4 - 17092118

Figure shows as a L-shaped tube in which a liquid of density ρ is filled. Find with what acceleration the tube is accelerated towards right so that no liquid will fall out of the tube.



CORRECT ANSWER: $\frac{HG}{L}$

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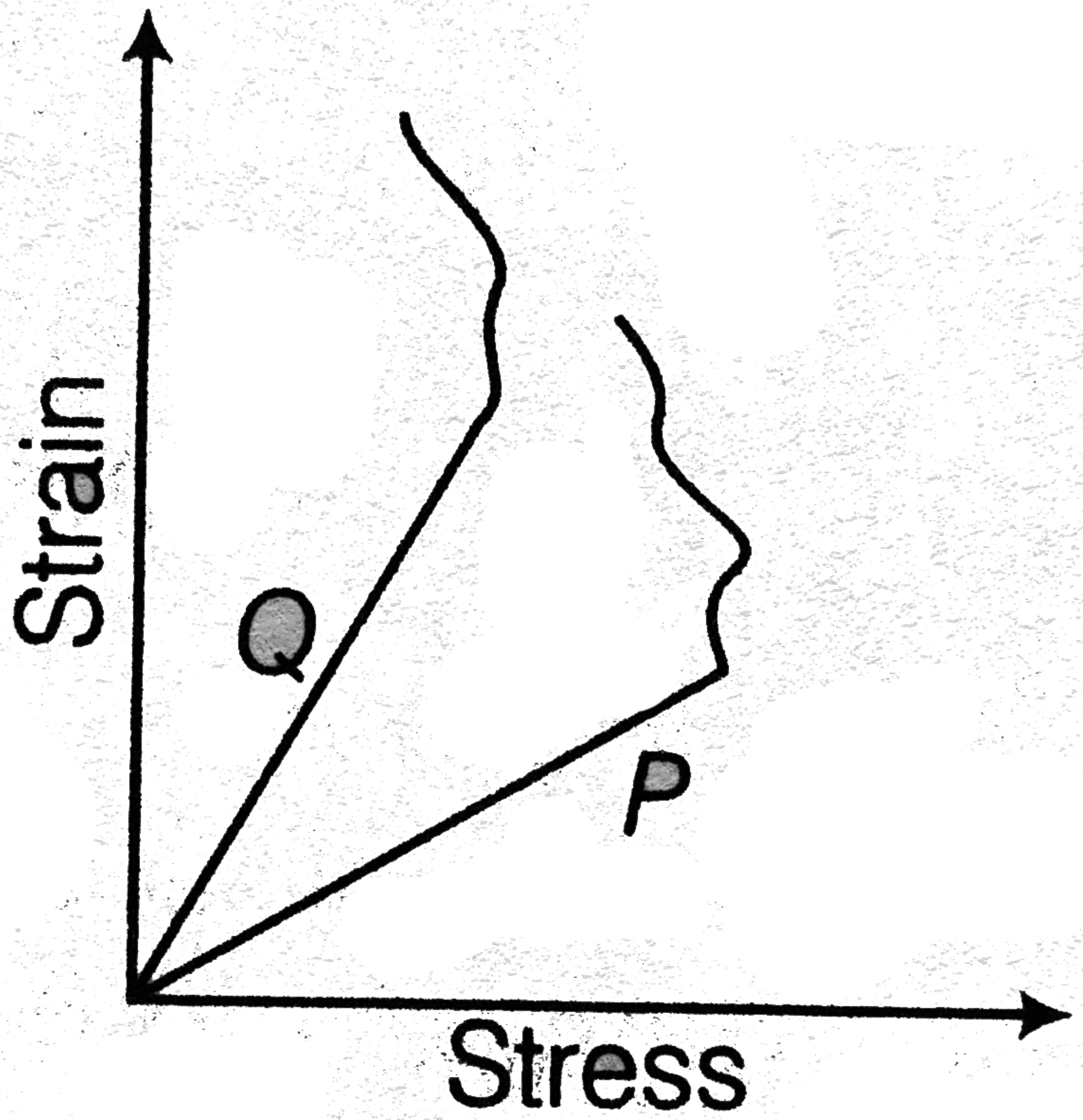
Q-5 - 10964775

Figure shows the stress-strain curve of two metals P and Q . From the graph, it can be concluded that



(A) (A) P has greater young's modulus and lesser ductility

(B) (B) Q has greater young's modulus and lesser ductility

(C) (C) P has greater young's modulus and greater ductility

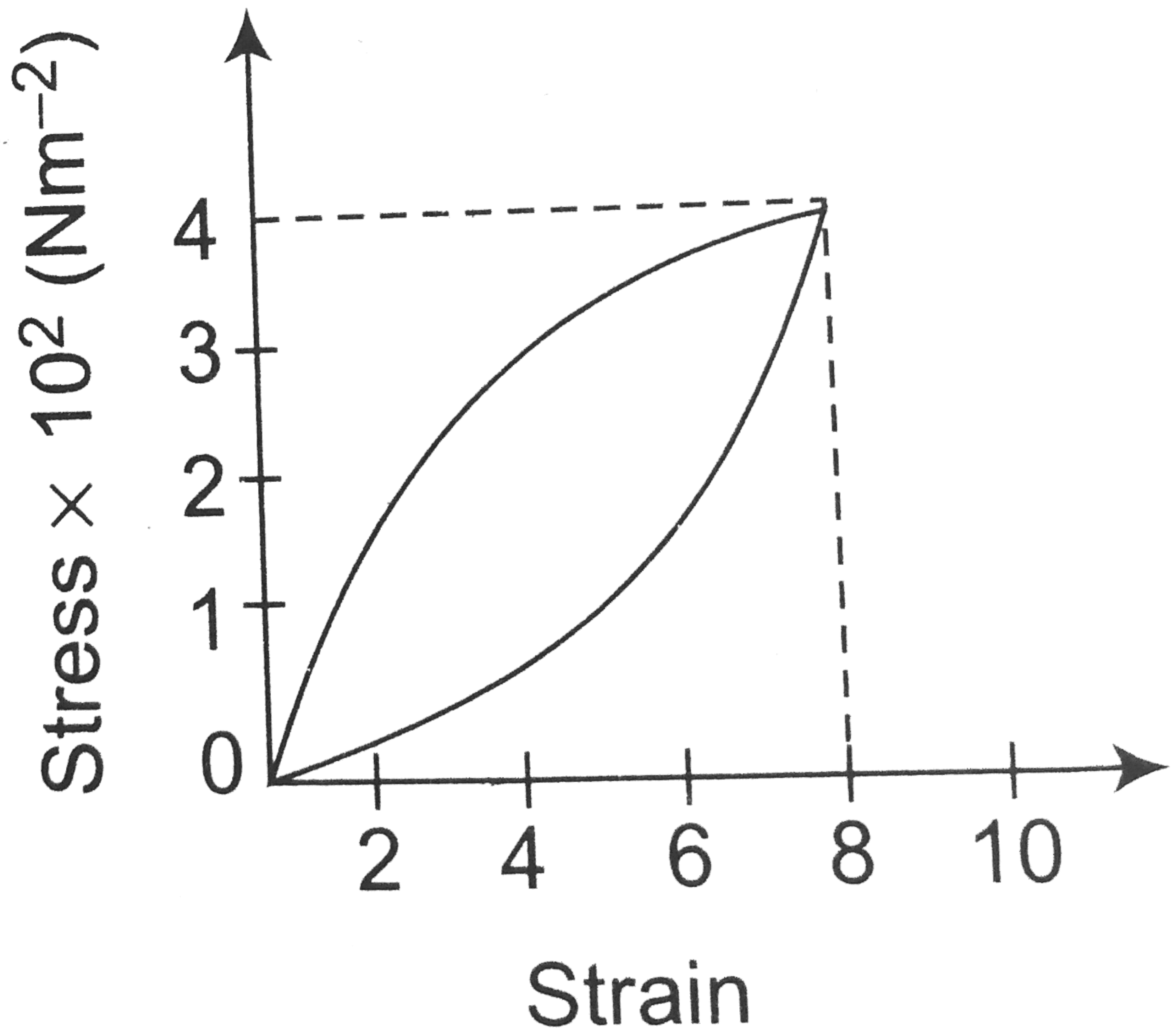
(D) (D) Q has greater young's modulus and greater ductility

CORRECT ANSWER: A

SOLUTION:

In the figure , the reciprocal of slope of stress - strain (x and y- axes) curve , upto proportionality limit, gives young's modulus. The measure of ductility is obtained as the length of the stress-strain curve between yield point and ultimate load.

Q-6 - 11748845



A rubber of volume 2000 cc is alternately subjected to tension and released. The figure shown the stress-strain curve of rubber. Each curve is a quadrant of an ellipse. The amount of energy lost as heat per cycle per unit volume will be

(A) $\left(\frac{\pi}{2}-1\right) \times 16 \times 10^2 J$

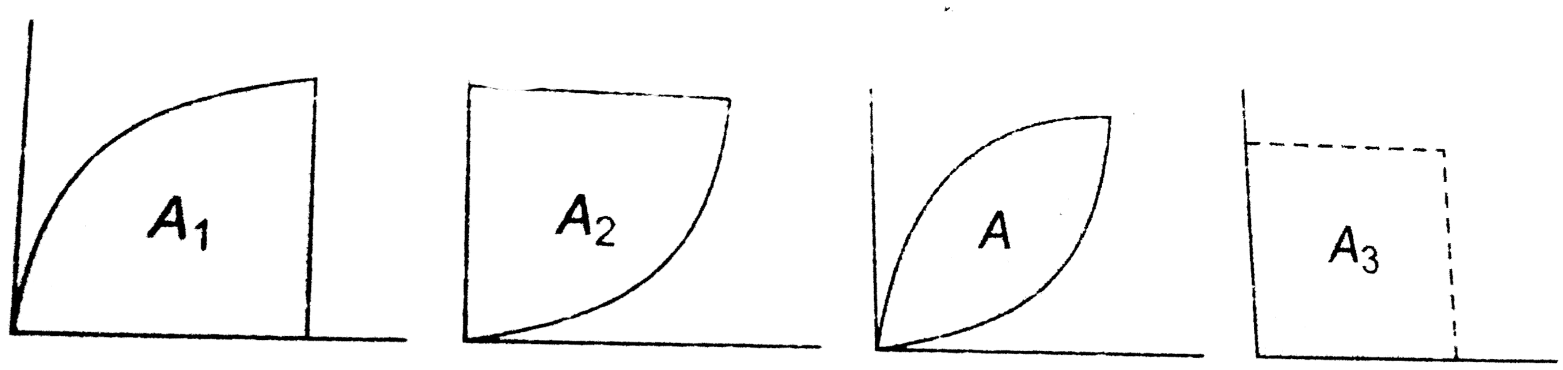
(B) $\left(\frac{\pi}{4}-1\right) \times 8 \times 10^2 J$

(C) $\left(\frac{\pi}{4}-1\right) \times 32 \times 10^2 J$

(D) $\left(\frac{\pi}{2}-1\right) \times 32 \times 10^2 J$

CORRECT ANSWER: D

SOLUTION:



Hysteresis loss corresponding to elasticity per unit volume of a substance is given by the area of hysteresis loop, i.e., stress-strain curve corresponding to one complete loading and deloading

Area of an ellipse $= \pi \times$ semi-major axis $\times$ semi-minor axis

$A_1 = \frac{1}{4}(\pi \times 8 \times 4$
$\times 10^2)$

and

$$A_2 = \frac{1}{4}\left(\pi \times 8 \times 4 \times 10^2\right)$$

Also, $A_3 = 8 \times 4 \times 10^2$

Area of hysteresis loop is $A = A_1 + A_2 + A_3$

$$A = 2\left[\frac{\pi}{4} \times 8 \times 4 \times 10^2\right] - \left[8 \times 4 \times 10^2\right]$$

$=$ work done per cycle

$=$ energy lost per cycle per unit volume.

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Q-7 - 12007952

Compute the fractional change in volume of a glass slab, when subjicted to a hydrautic pressure of 10 atmosphere. Bulk modulus of elasticity of glass = $37 \times 10^{9} Nm^{-2}$ and 1 atm = $1.013 \times 10^{5} Pa$.

SOLUTION:

Here,

$p = 10atm, = 10$

$\times 1.013 \times 10^{5} Pa, B$

$= 37 \times 10^{9} Nm^{-2}$

Volumetric strain =

$$\frac{\Delta V}{V} = \frac{p}{B}$$

$$= \frac{10 \times 1.013 \times 10^{5}}{37 \times 10^{9}}$$

$$= 2.74 \times 10^{-5}$$

$\therefore$ Froctional change in volume =

$$\frac{\Delta V}{V} = 2.74 \times 10^{-5}.$$

Q-8 - 11748765

A sample of a liquid has an initial volume of 1.5 L The volume is reduced by 0.2 mL, when the pressure increases by 140 kPz. What is the bulk modulus of the liquid?

(A) $1.05 \times 10^9 Pa$

(B) $3.05 \times 10^9 Pa$

(C) $2.10 \times 10^9 Pa$

(D) $5.10 \times 10^9 Pa$

CORRECT ANSWER: A

SOLUTION:

$$B = -\frac{\triangle P}{\frac{\triangle V}{V}} =$$

$$-\frac{V \triangle P}{trian \geq lV} =$$

$$-\frac{1.5 \times 140 \times 10^3}{-0.2 \times 10^{-3}}$$

$$= 1.05 \times 10^9 Pa$$

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Q-9 - 18254305

A body of mass m = 0 kg is attached to a wire of length 0.3 m. Calculate the maximum angular velcoity with wicch it can be rotated in a horizontal circle (Breaking stress of wire $= 4.8x10^7 N/m^2$ and area of cross-section of wire = $10^{-6} m^2$)

(A) $4rad/s$

(B) $8rad/s$

(C) $1 rad / s$

(D) $2 rad / s$

CORRECT ANSWER: A

SOLUTION:

(a) Breaking strength=tension in the wire =$mr\omega^2$

$4.8 \times 10^7 \times 10^{-6} = 10$
$\times 0.3 \times \omega^2$

$\omega^2 = \frac{48}{0.3 \times 10} = 16$
$\Rightarrow \omega = 4$
rad/s

Q-10 - 10964769

The young's modulus of a wire of length (L) and radius (r) is Y. If the length is reduced to $\frac{L}{2}$ and radius $\frac{r}{2}$, then its young's modulus will be

(A) $\frac{Y}{2}$

(B) Y

(C) $2Y$

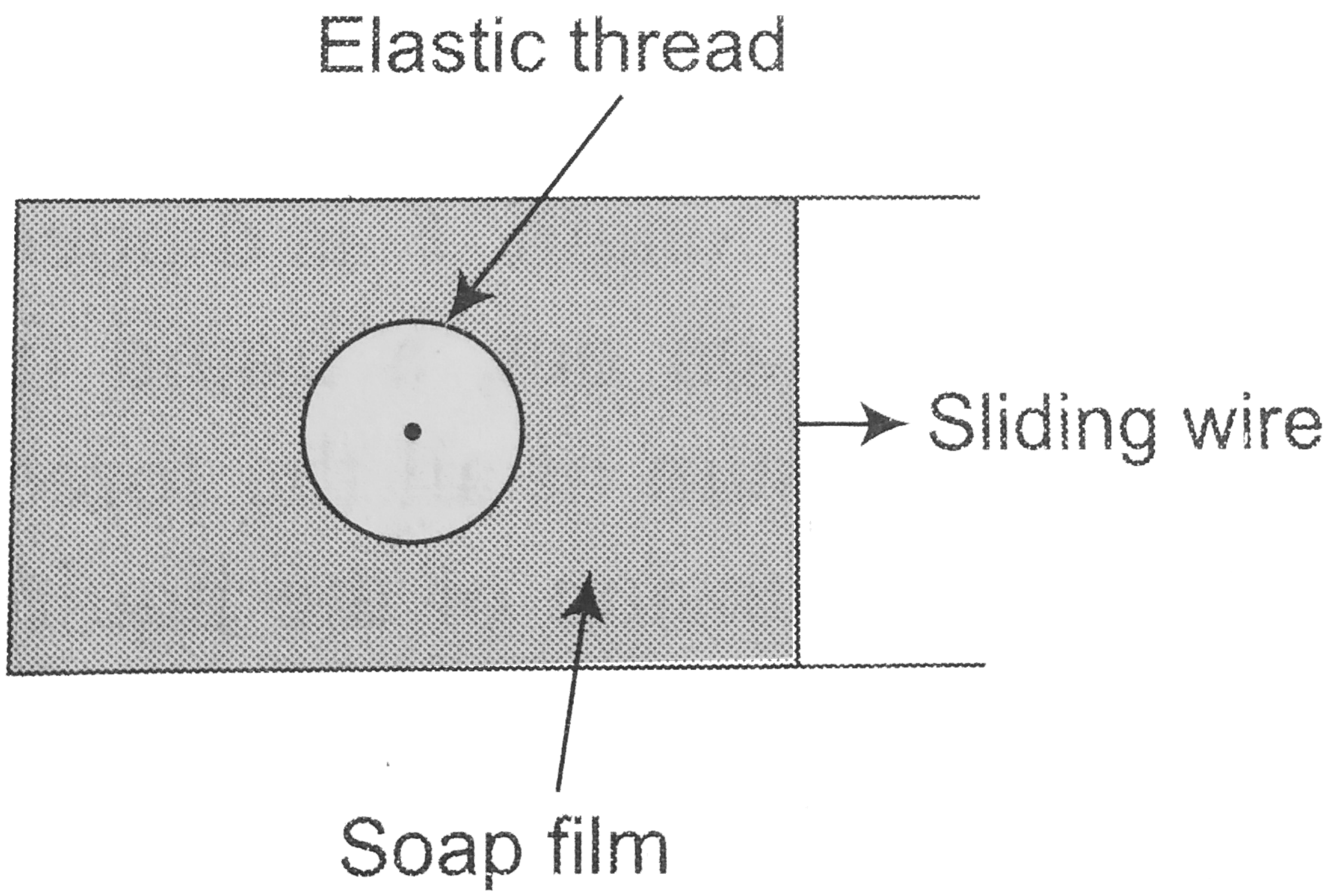
(D) $4Y$

CORRECT ANSWER: B

SOLUTION:

young's modulus of elasticity is a materials property.

Q-11 - 11748864



The figure shows a soap film in which a closed elastic thread is lying. The film inside the thread is pricked. Now the sliding wire is moved out so that the surface area increases. The radius circle of the circle formed by elastic thread will

(A) increase

(B) decrease

(C) remains same

(D) data insufficient

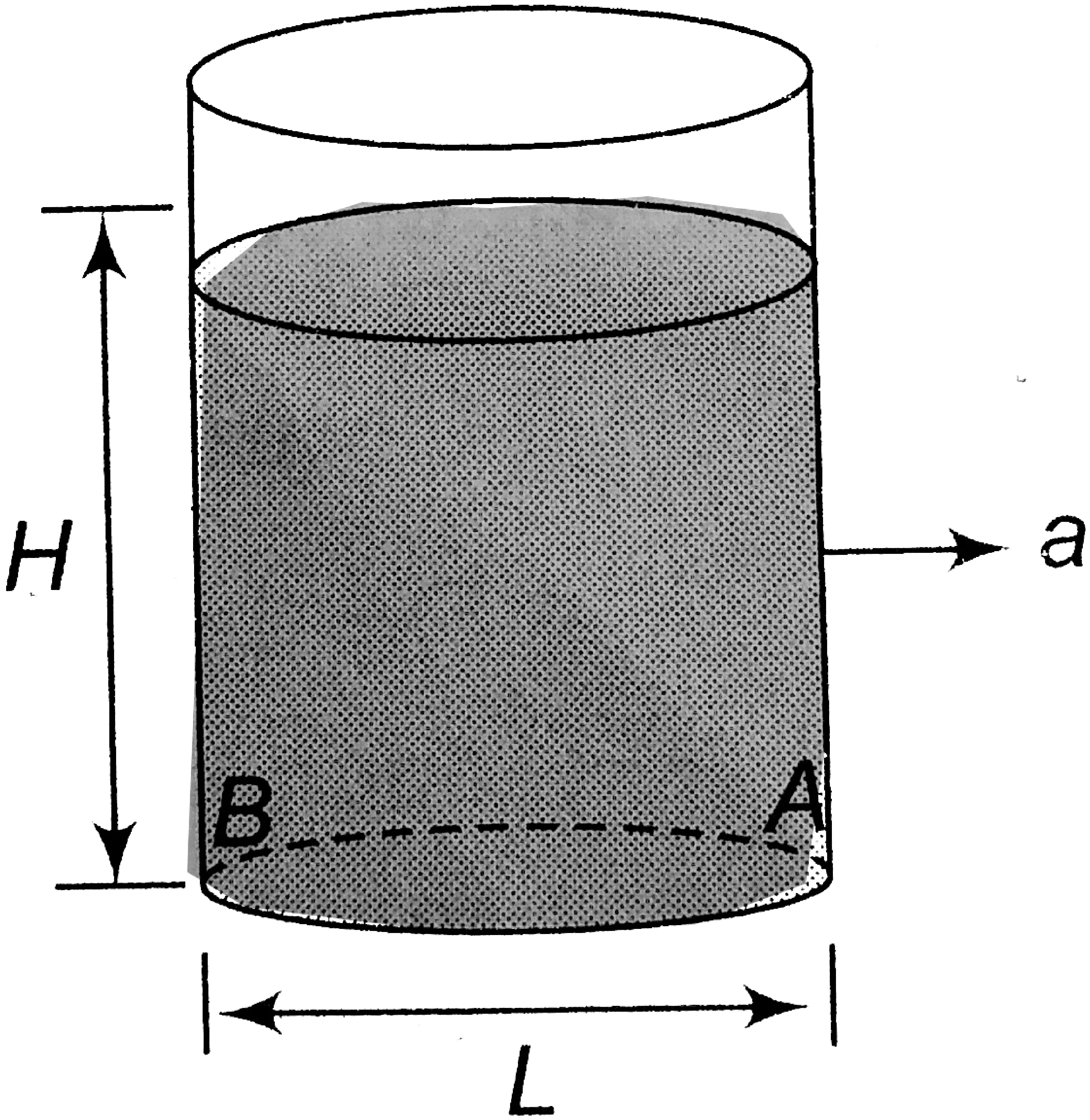
CORRECT ANSWER: C

SOLUTION:

The force exerted by film on wire or thread depends only on the nature of material of the film and not on its surface area. Hence the radius of circle formed by elastic thread dows not change.

Q-12 - 11796538

A tank with base area L^2 is filled with a liquid to height H. The tank is acceleration horizontally with acceleration a as shown in figure. If a small hole is made at the point A. then it is observed that the liquid does not come out of the tank. The magnitude of acceleration should be



(A) $\frac{H}{L}g$

(B) $\frac{L}{H}g$

(C) g

(D) None of these

CORRECT ANSWER: D

SOLUTION:

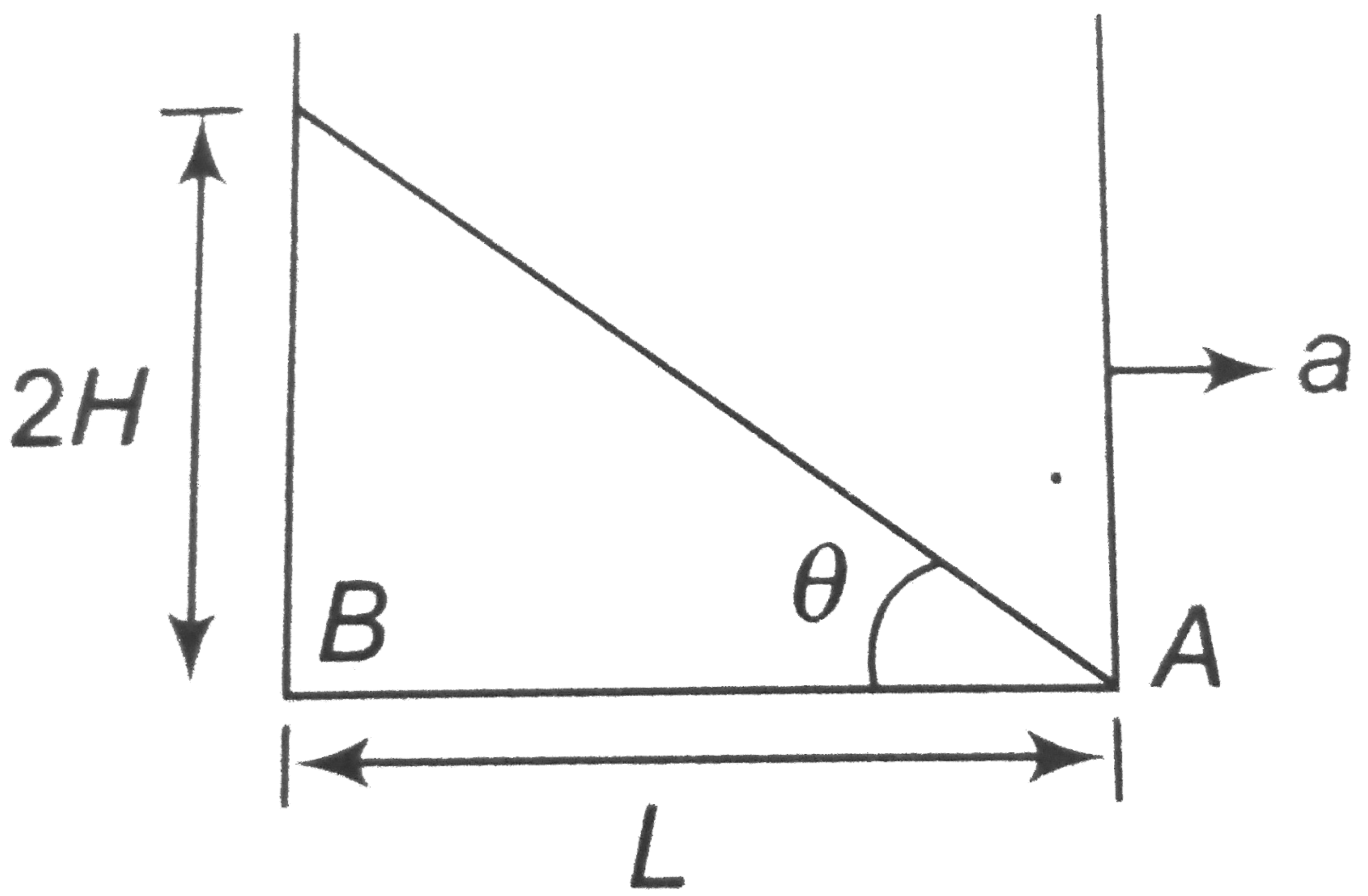
(d) The liquid will not come out of the tank at the point A if the free surface passes through the point itself.

$$\therefore \tan\theta = \frac{2H}{L}$$

$$= \frac{a}{g} \text{ or } a$$

$$= \left(\frac{2H}{L}\right)g$$

Note that volume of water in the tank remains constant.



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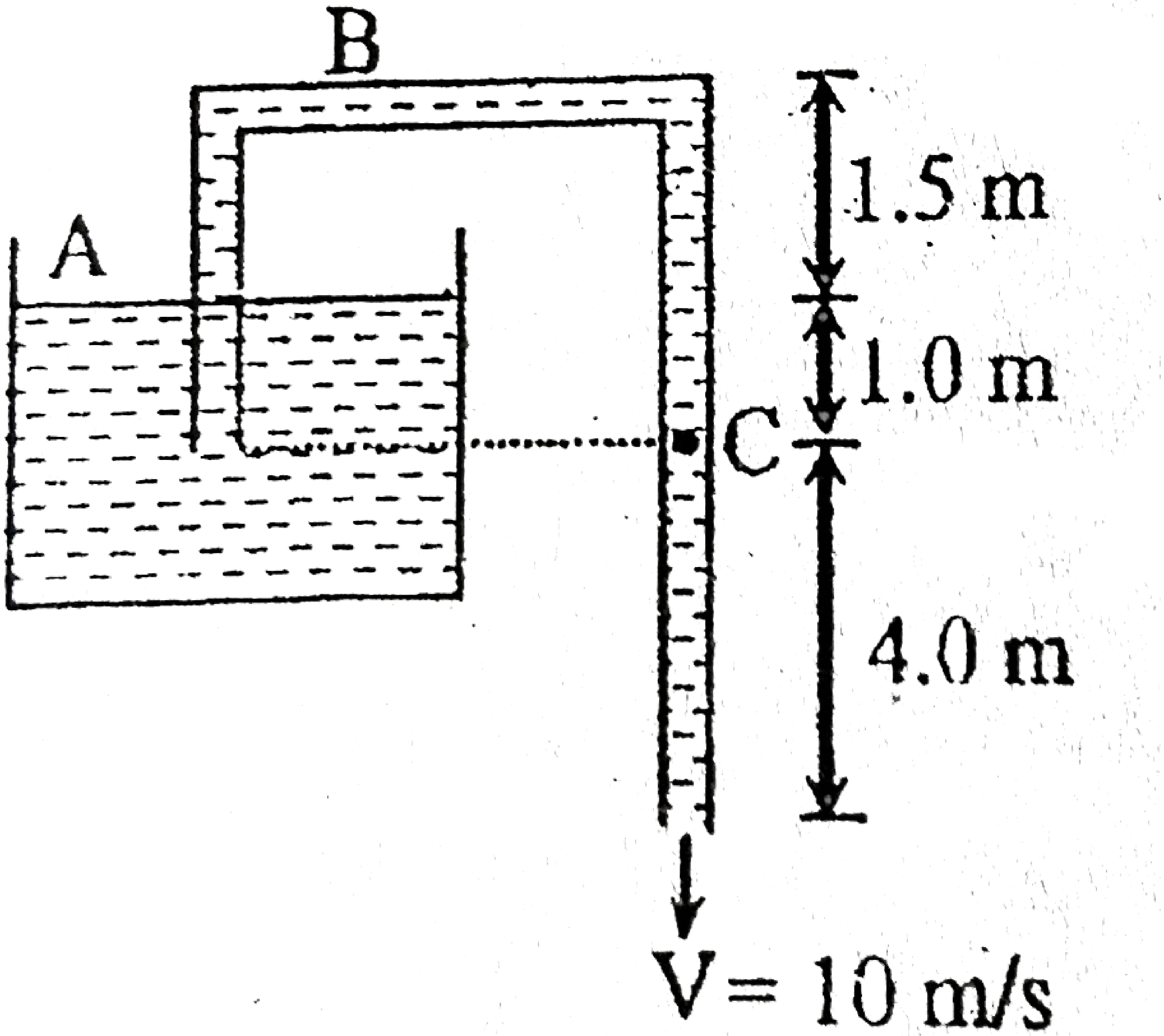
Q-13 - 14626546

A siphon tube is discharging a liquid of density $900 \frac{kg}{m^3}$ as shown in figure. $\left(P_0 = 1.01 \times 10^5 N/m^2\right)$



Pressure at point B is

(A) $4.25x10^4 N/m^2$

(B) $6.25 \times 10^4 N/m^2$

(C) $2.50 \times 10^4 N/m^3$

(D) $2.0 \times 10^5 N/m^2$

CORRECT ANSWER: A

SOLUTION:

Applying Bernoull's theorem at A and B, we

have

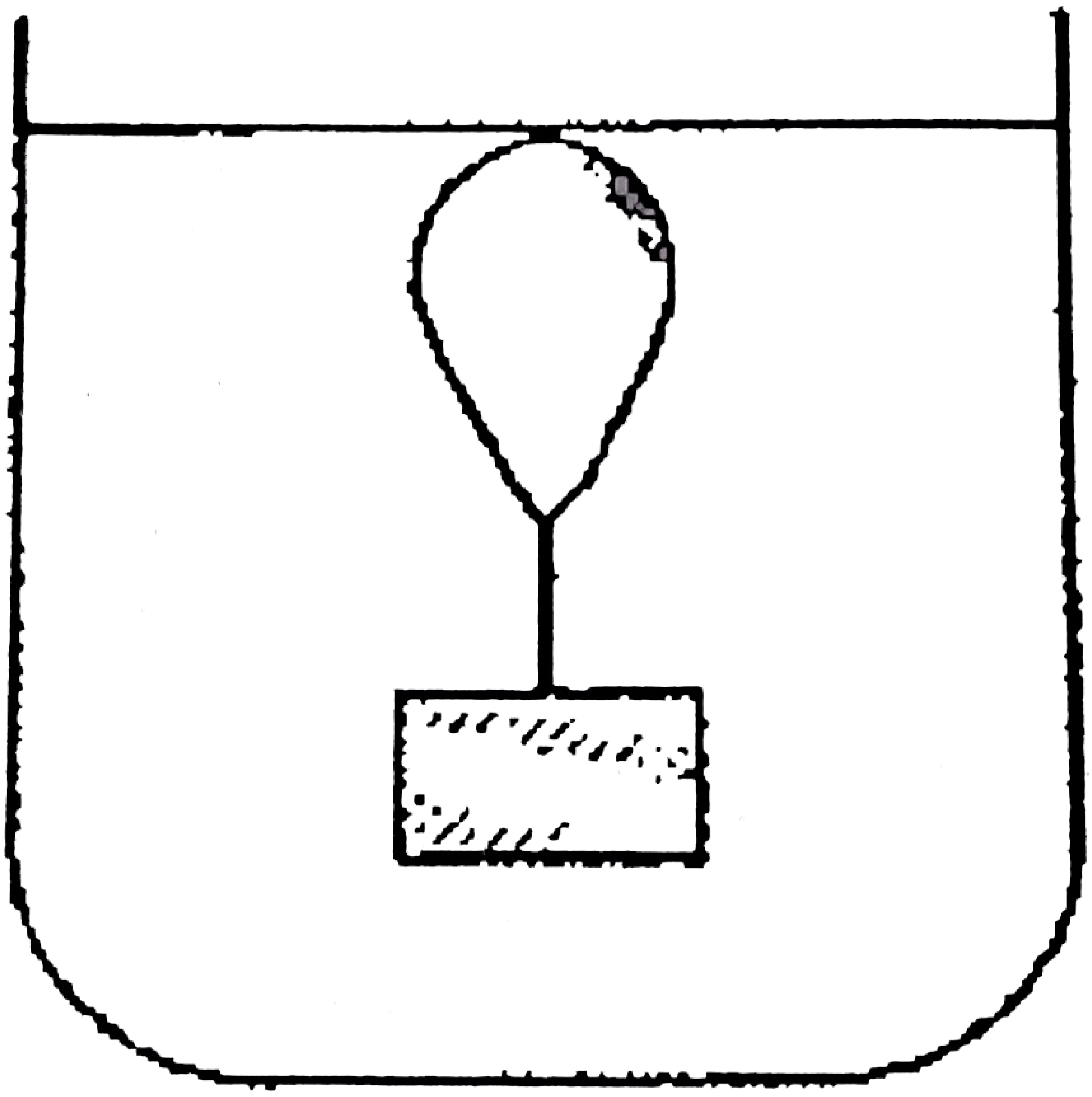
$$P_0 + 0 + 0 = P_B + \frac{1}{2}pv^2 + pg(1.5)$$

or

$$P_B = \left(1.01 \times 10^5\right) - \frac{1}{2} \times 900 \times (10)^2 - 900$$

$$\times 10 \times 1.5 = 4.25 \times 10^4 N/m^2 \uparrow$$

Q-14 - 14159272



A ballong filled with air is weighted so that it barely floats in water as shown in figure. When it is pushed down so that it gets submerged a short distance in water then the balloon

(A) will come up again to its former position

(B) will remain in the position it is leftq

(C) will sink to the bottom

(D) will emerge out of liquid.

CORRECT ANSWER: C

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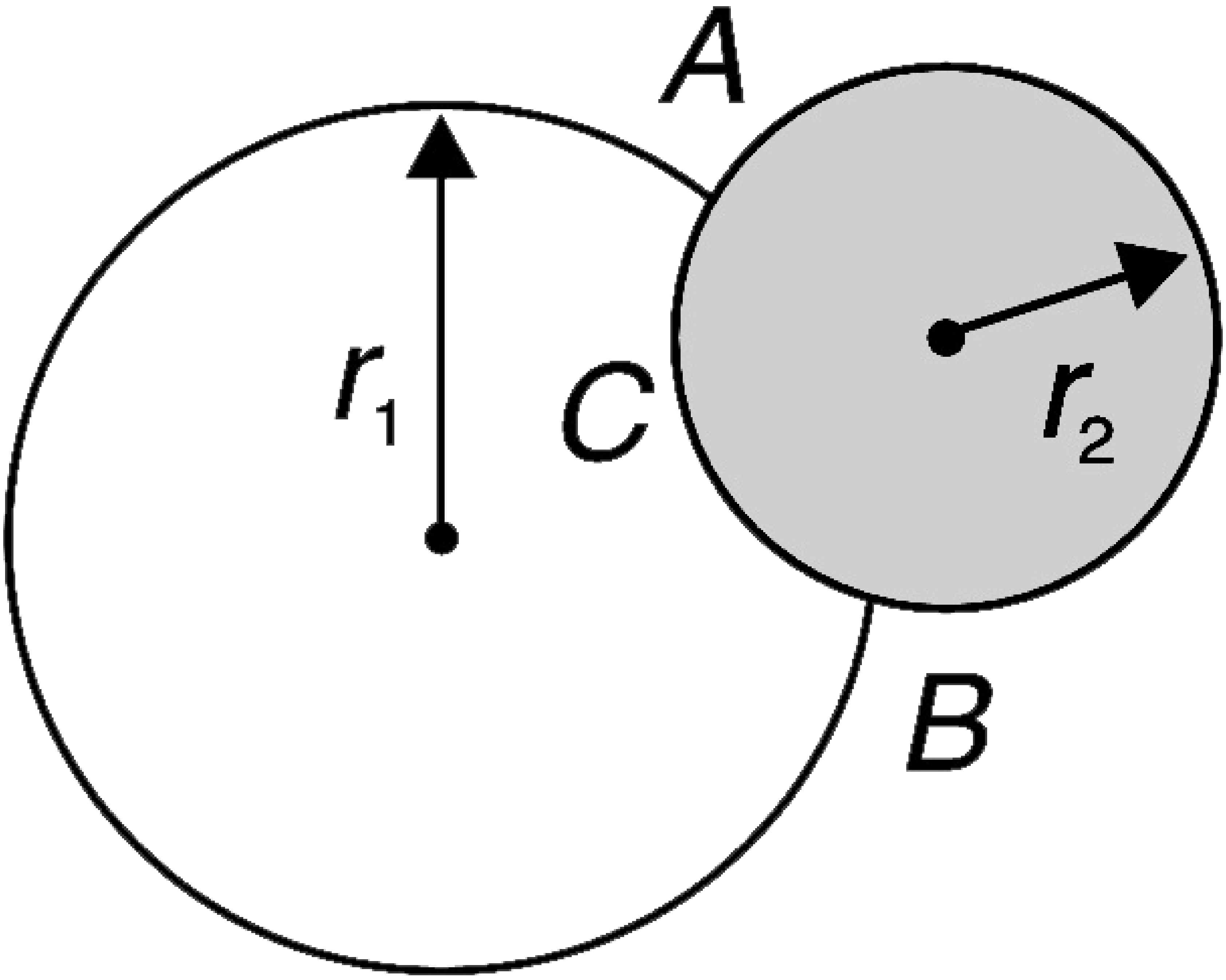
Q-15 - 15085626

Two soap bubbles of radii r_1 and r_2 are attached as shown. Find the radius of curvature of the common film ACB.



CORRECT ANSWER: $\frac{R_1 R_2}{R_1 - R_2}$

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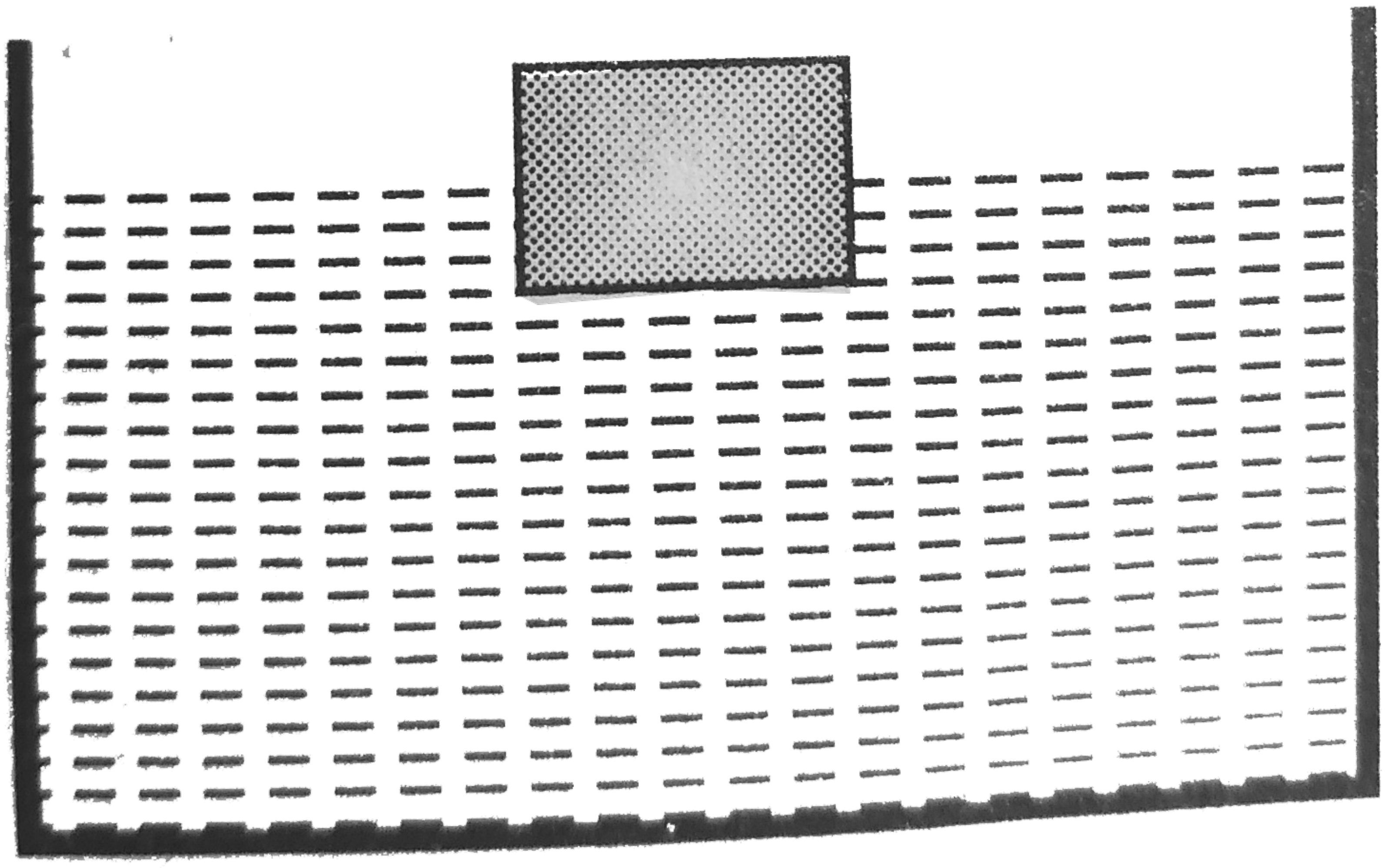
Q-16 - 11796568

A cubical block is floating in a liquid with half of its volume immersed in the liquid. When the whole system accelerates upwards with acceleration of $g/3$, the fraction of volume immersed in the liquid will be



(A) $\frac{1}{2}$

(B) $\frac{3}{8}$

(C) $\frac{2}{3}$

(D) $\frac{3}{4}$

CORRECT ANSWER: A

SOLUTION:

Fraction of volume immersed in the liquid $V_m = \left(\frac{\rho}{\sigma}\right)V$

ie., it depends upon the densities of the block and liquid.

So there will be no change in it if system moves upward or downward with constant velocity or some acceleration.

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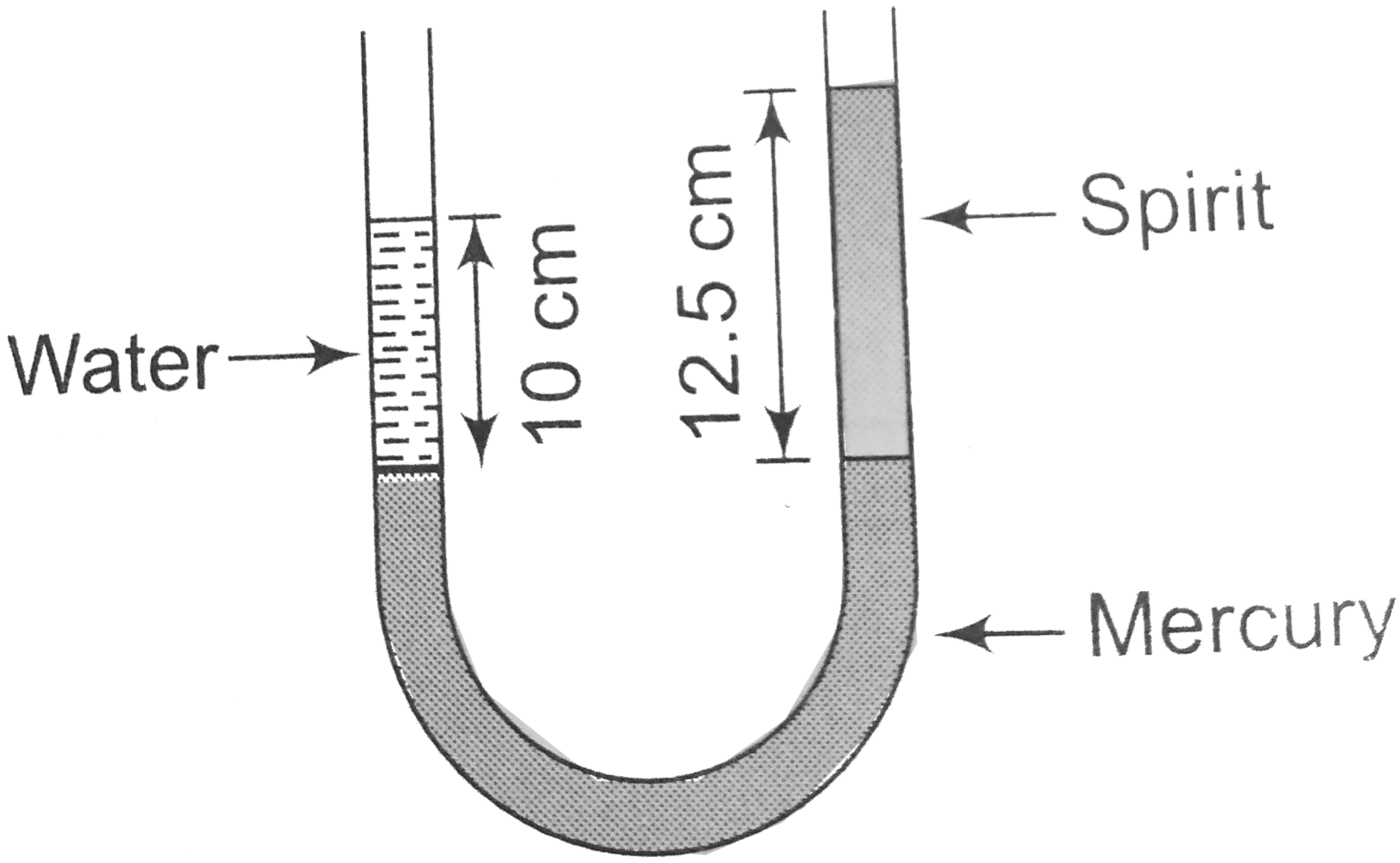
Q-17 - 11796518

A U tube contains water and methylated spirit separted by mercury. The mercury colums in the tow arms are at the same level with 10 cm of water in one are and 12.5 cm of spirit in the other as shown in figure. The relative density of the spirit is



(A) 0.6

(B) 0.8

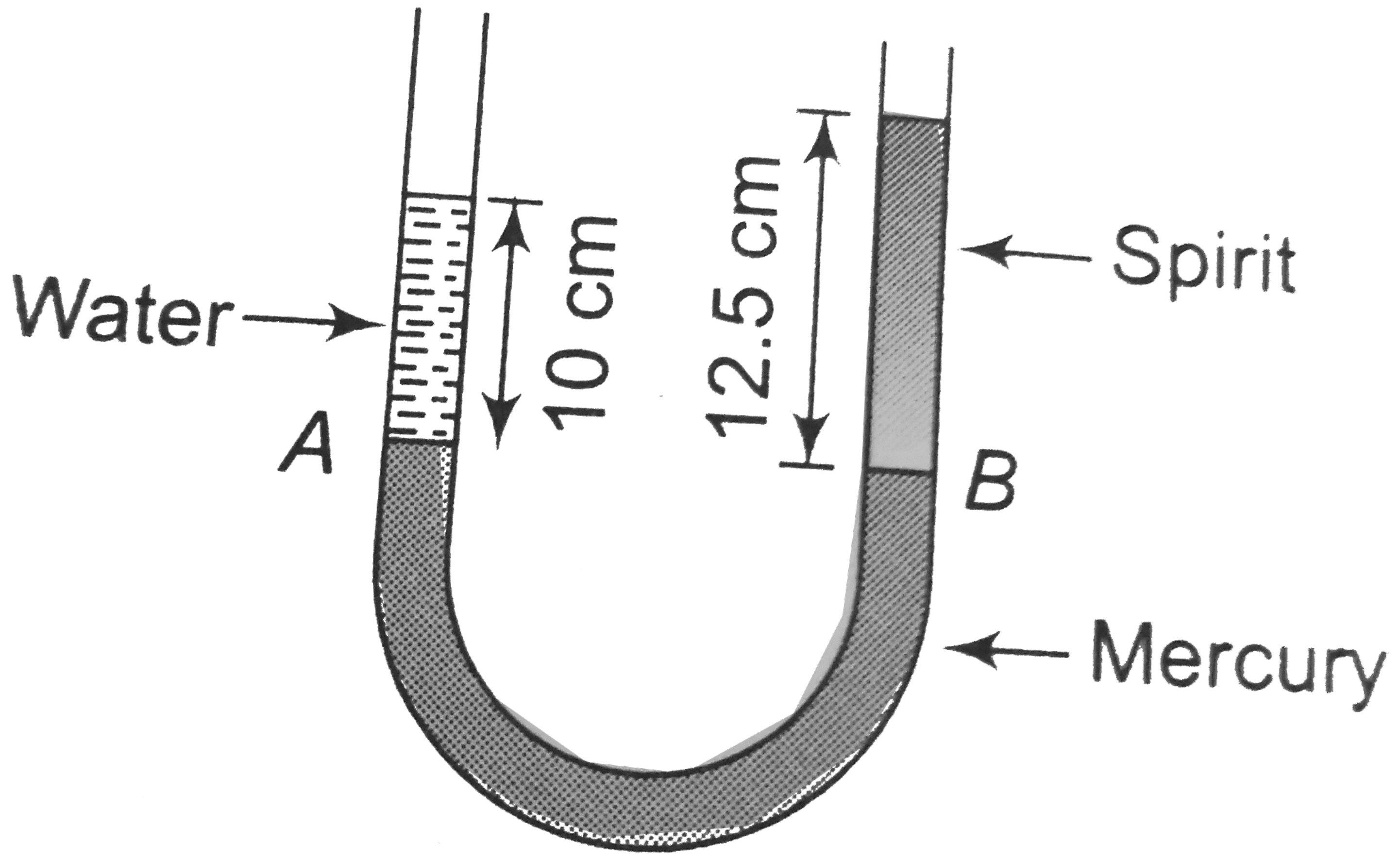
(C) 1

(D) 1.25

CORRECT ANSWER: B

SOLUTION:

(b) Refer figure. As the mercury columns in the two arms of U tube are at the same level, therefore



Pressure due to water = Pressure due to spirit colum

$$\rho w_h w_g = \rho_g h_g$$

$$\rho_s = \frac{h_w}{h_s} \rho_w$$

:. Relativedensity of spirit

$$= \frac{\rho_s}{\rho_w} = \frac{h_w}{h_s}$$

$$= \frac{10cm}{12.5cm} = 0.8$$

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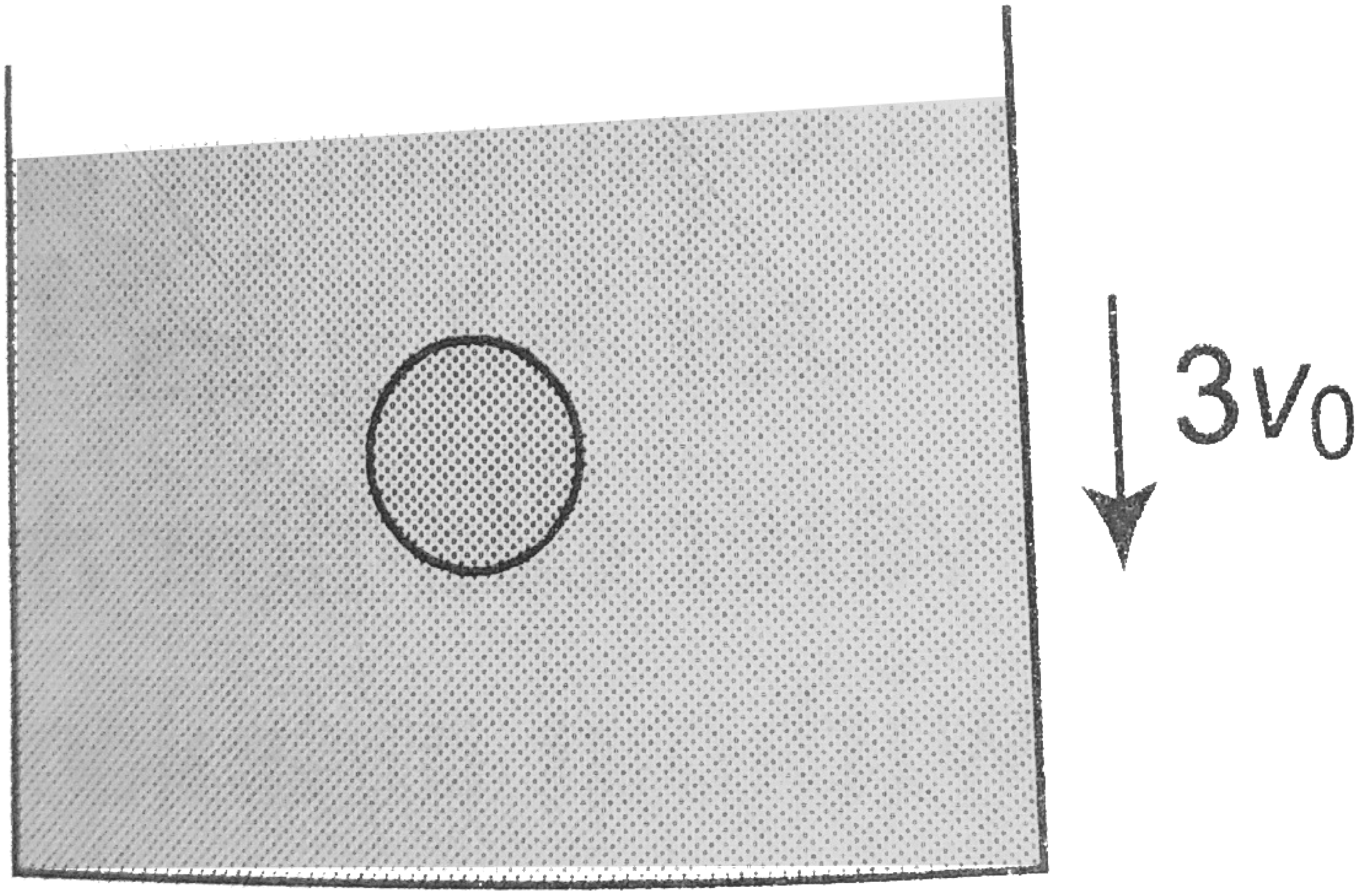
Q-18 - 11748940



A container filled with viscous liquid is moving vertically downwards with constant speed $3v_0$. At the instant shown, a sphere of radius r is moving vertically downwards (in liquid) has speed v_0. The coefficient of viscosity is η. There is no relative motion between the liquid and the container. Then at the shoen instant, The magnitude of viscous force acting on sphere is

(A) $6\pi\eta r v_0$

(B) $12\pi\eta r v_0$

(C) $18\pi\eta r v_0$

(D) $24\pi\eta r v_0$

CORRECT ANSWER: B

SOLUTION:

Relative to liquid, the velocity of sphere is $2v_0$ upwards.

Viscous force of sphere $= 6\pi\eta r 2v_0$ downward

$= 12\pi\eta r v_0$ downward

Q-19 - 12008296

Two equal drops of water falling through air with a steady velocity $5cm/s$. If the drops combire to from a single drop, what will be new terminal velocity?

SOLUTION:

Here, $v = 5cms^{-1}$ .Let r be the radius of each drop.

Terminal velocity of each drop is

$$v = \frac{2\pi r^2(\rho - \sigma)g}{9\eta} = 5 \text{ (i)}$$

Let R be the radius of by drop formed when two small

drop coalese together. Then

$$\frac{4}{3}\pi R^3 = 2 \times \frac{4}{3}\pi r^3 \text{ or } R = 2^{1/3}r$$

Terminal velocity of big drop is

$$v = \frac{2R^2(\rho - \sigma)g}{9\eta} \text{ .....(ii)}$$

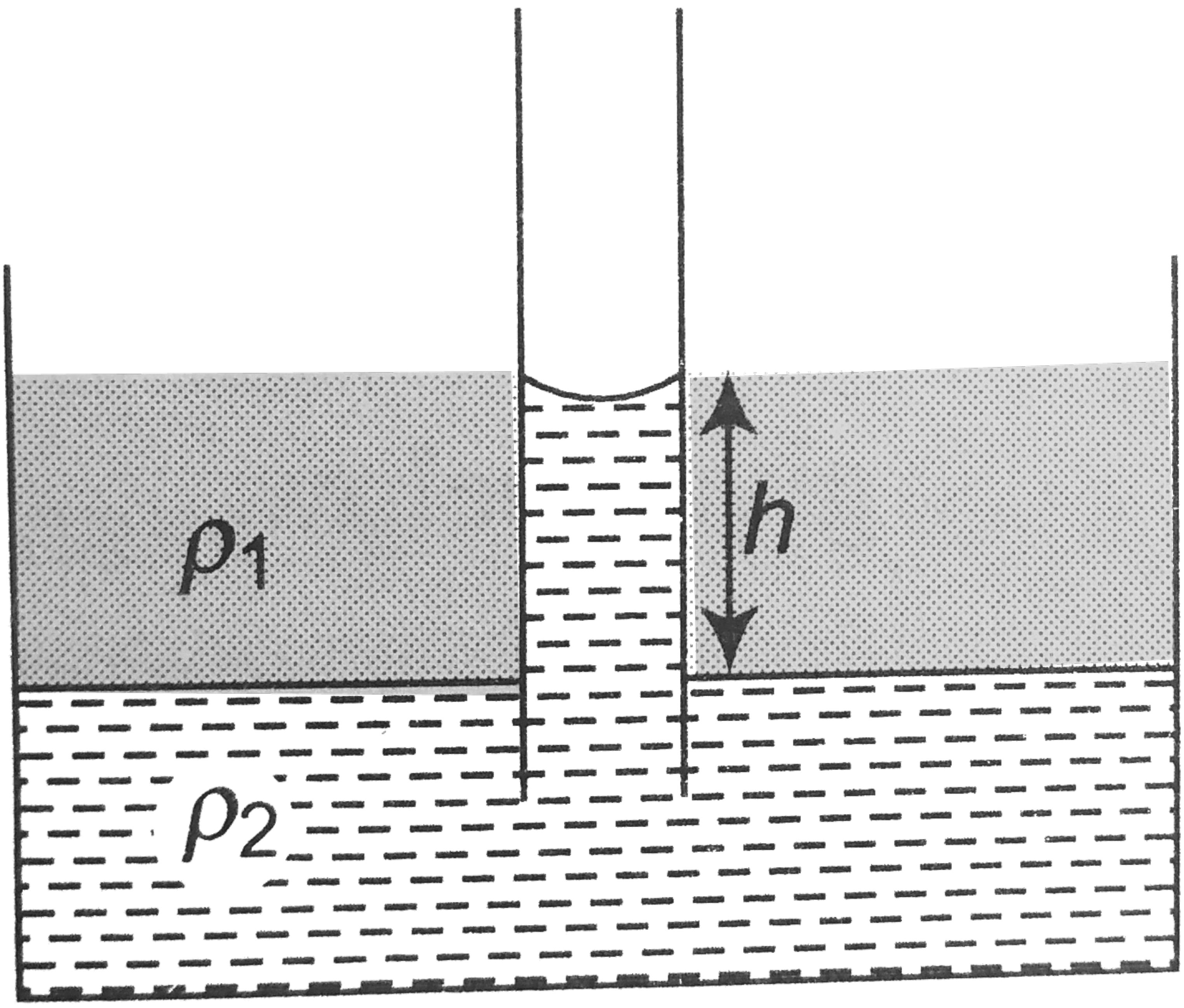
Dividing (ii) by (i), we get

$$\frac{V}{5} = \frac{R^2}{r^2} \text{ or } V = 5 \times \frac{R^2}{r^2}$$

$$V = 5 \times \frac{\left(2^{1/3}r\right)^2}{r^2}$$

$$= 5 \times 2^{2/3} = 5 \times 1.5874$$

$$= 7.937cms^{-1}$$



A container is partially filled with a liquid of density ρ_2 A capillary tube of radius r is vertically inserted in this liquid. Now another liquid of density $\rho_1 (\rho_1 < \rho_2)$ is slowly poured in the container to a height h as shown. There is only denser liquid in the capillary tube. The rise of denser liquid in the capillary tube is also h. Assuming zero contact angle, the surface tension of heavier liquid is

(A) $r\rho_2 gh$

(B) $2\pi r\rho_2 gh$

(C) $\frac{r}{2}(\rho_2 - \rho_1)gh$

(D) $2\pi r(\rho_2 - \rho_1)gh$

CORRECT ANSWER: C

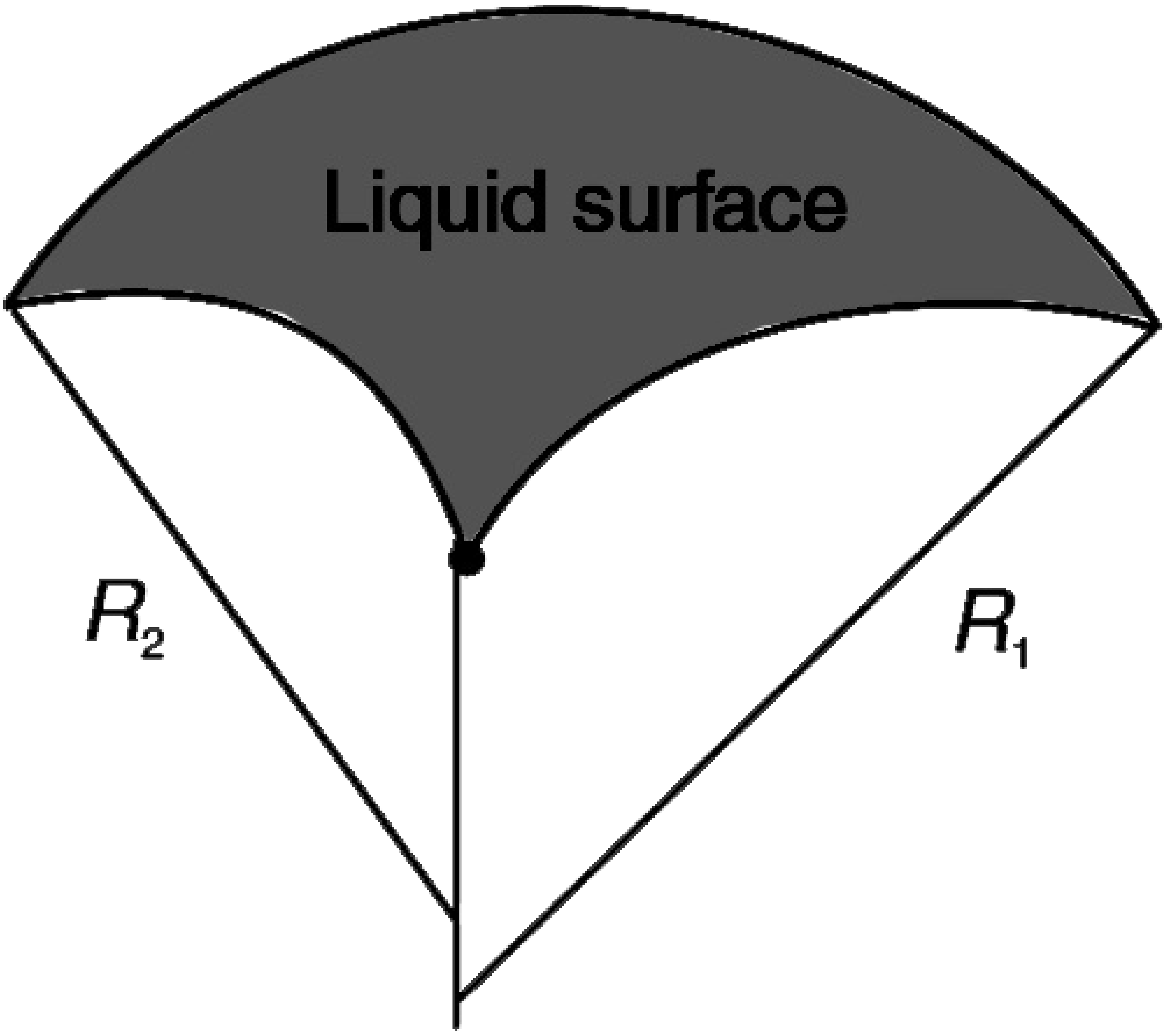
SOLUTION:

$$P_0 + \rho_1 gh - \rho_2 gh + \frac{2T}{r} = P_0$$

$$\Rightarrow T = \frac{r}{2}(\rho_2 - \rho_1)gh$$

Q-21 - 15085640

A curved liquid surface has radius of curvature R_1 and R_2 in two perpendicular directions as shown in figure. Surface tension of the liquid is T. Find the difference in pressure on the concave side and the convex side of the liquid surface.



CORRECT ANSWER:

$$DELTAP = T\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$$

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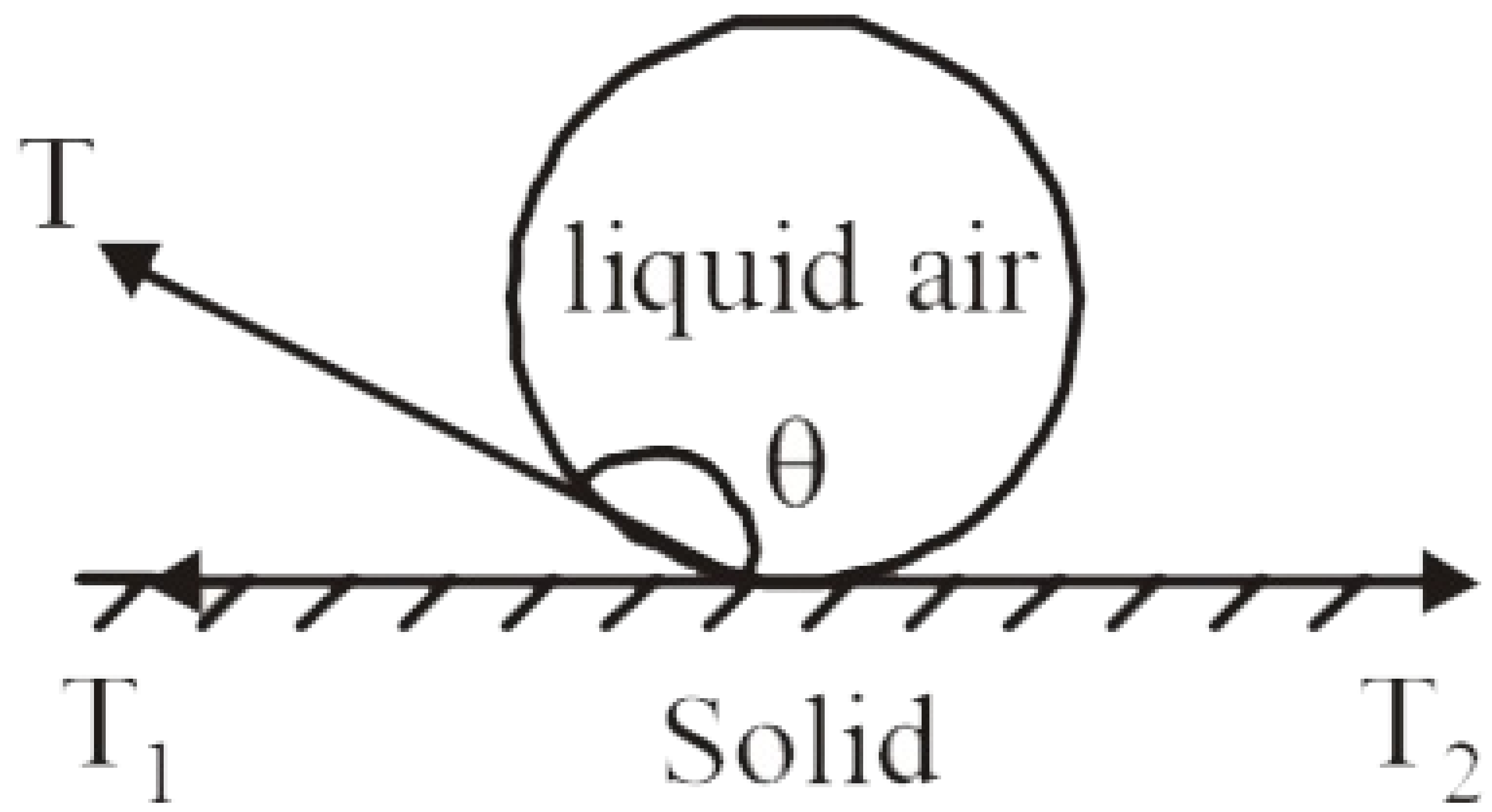
Q-22 - 14927731

Let T_1 be surface tension between solid and air, T_2 be the surface tension between solid and liquid and T be the surface tension between liquid and air. Then in equilibrium, for a drop of liquid on a clean glass plate, the correct relation is (θ is angle of contact)



(A) $\cos\theta = \dfrac{T}{T_1 + T_2}$

(B) $\cos\theta = \dfrac{T}{T_1 - T_2}$

(C) $\cos\theta = \dfrac{T_1 + T_2}{T}$

(D) $\cos\theta = \dfrac{T_1 - T_2}{T}$

Q-23 - 14162001

A liquid is flowing through a horizontal channel. The speed of flow (v) depends on height (y) from the floor as $v = v_0\left[2\left(\frac{y}{h}\right) - \left(\frac{y}{h}\right)^2\right]$. Where h is the height of liquid in the channel and v_0 is the speed of the top layer. Coefficient of viscosity is η. Then the shear stress that the liquid exerts on the floor is.

(A) $\frac{2\eta v_0}{h}$

(B) $\frac{3\eta v_0}{h}$

(C) $\frac{4\eta v_0}{h}$

(D) $\frac{2\eta v_0}{3h}$

CORRECT ANSWER: A

SOLUTION:

Shear stress is tangential force applied by the liquid on unit area of the floor:

Velocity gradient $= \frac{dv}{dy} = \frac{2v_0}{h} - \frac{2v_0}{h_2} y$

At $y = 0, \frac{dv}{dy} = \frac{2v_0}{h}$

$\therefore$ Viscous force per unit area $= \eta \frac{dv}{dy} = \frac{2\eta v_0}{h}$

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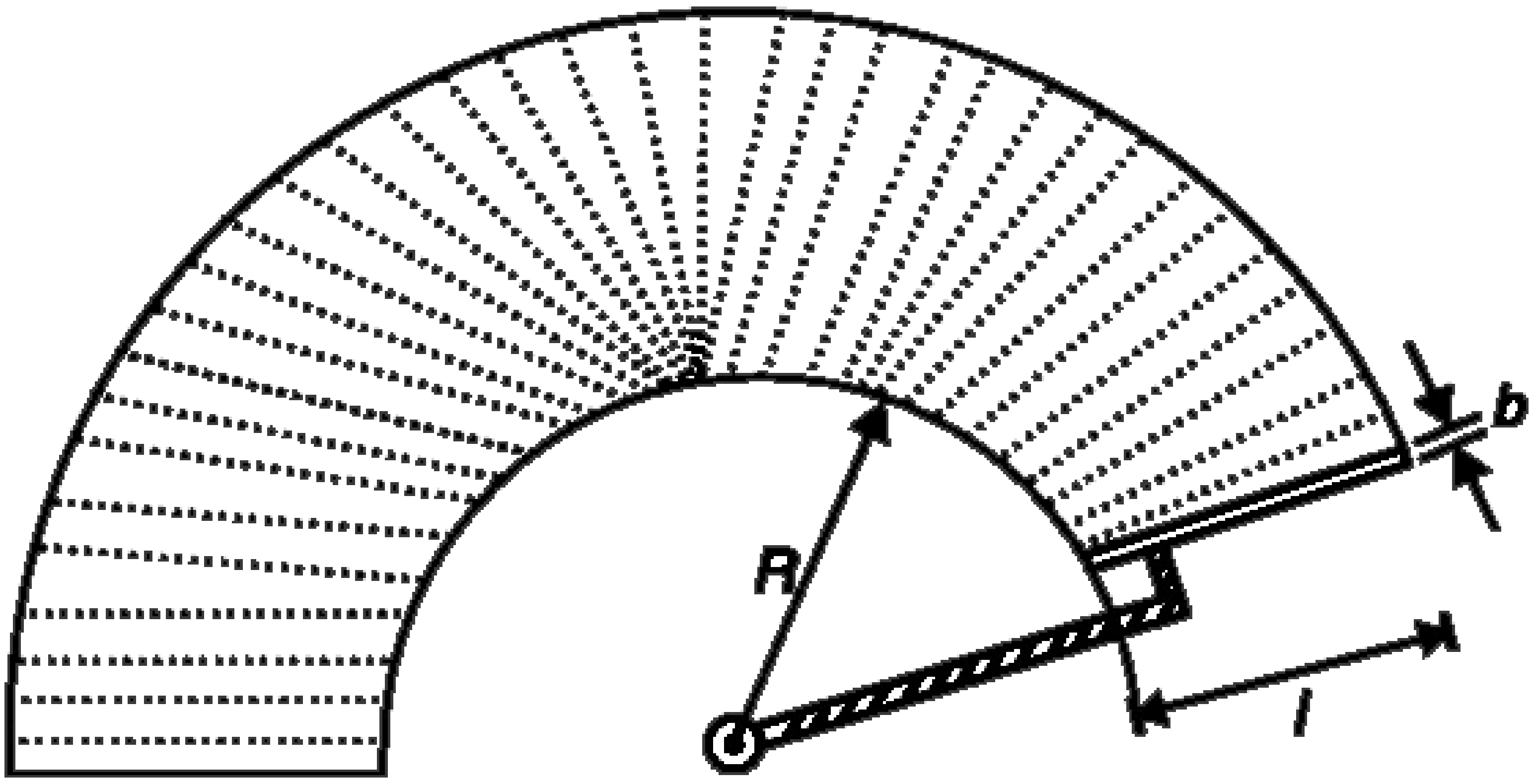
Q-24 - 15085480

A car windshield wiper blade sweeps the wet windshield rotating at a constant angular speed of ω. R is the radius of innermost arc swept by the blade. Length and width of the blade are l and b respectively. Coefficient of viscosity of water is η. Calculate the torque delivered by the motor to rotate the blade assuming that there is a uniform layer of water of thickness t on the glass surface.



CORRECT ANSWER:

$$\frac{ETARHOOMEGAR^3}{3T}\left[\left(1=\frac{L}{R}\right)^3-1\right]$$

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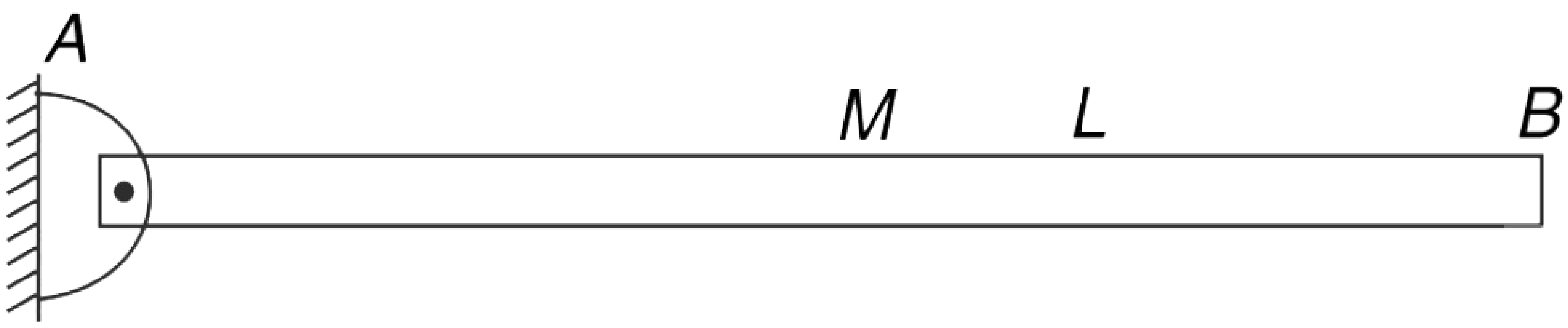
Q-25 - 15085496

A thin uniform rod of mass M and length L is free to rotate in vertical plane about a horizontal axis passing through one of its ends. The rod is released from horizontal position shown in the figure. Calculate the shear stress developed at the centre of the rod immediately after it is released. Cross sectional area of the rod is A.

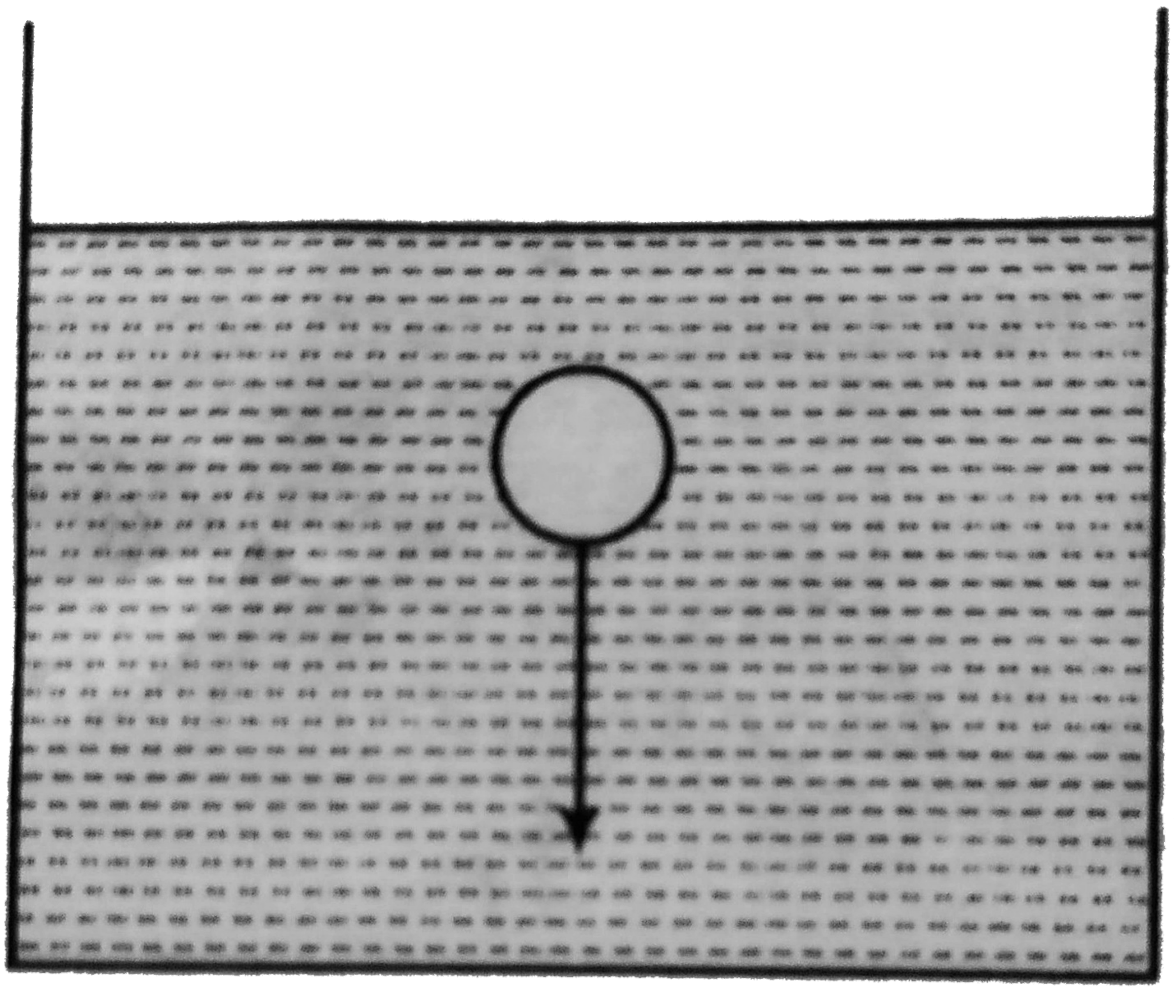
[For calculation of moment of inertia you can treat it to very thin]



CORRECT ANSWER: $\frac{MG}{16A}$

Q-26 - 10964883

A ball of volume V and density ρ_1 is moved downwards by a distance 'd' in liquid of density ρ_2. Find total change in potential energy of the system.



CORRECT ANSWER: A::B::D

SOLUTION:

Decrease in potential energy of the ball.

$= m_1 gh (m_1 =$ mass of ball)

$= (V_{\rho_1}) gd$

or, $\Delta U_1 = -V_{\rho_1} gd$

When V volume of solid comes down, then it is replaced by V volume of liquid.

$\therefore$ Increase in potential energy of liquid:

$= m_2gh(m_2 =$ mass of liquid of volume $V)$

$= (V_{\rho_2})gd$

or, $\therefore \Delta U_2 = -V_{\rho_2}gd$

Total change in potential energy.

$\Delta U = \Delta U_1 + \Delta U_2$

$= V(\rho_2 - (\rho_1)gd$

.

Q-27 - 15599939

Three liquids of densities ρ_1, ρ_2 and ρ_3 (with $\rho_1 > \rho_2 > \rho_3$), having the same value of surface tension T, rise to the same height in three identical capillaries. The angles of contact θ_1, θ_2 and θ_3 obey

(A) $\frac{\pi}{2} > \theta_1 > \theta_2 > \theta_3 \geq 0$

(B) $0 \leq \theta_1 < \theta_2 < \theta_3 < \frac{\pi}{2}$

(C)

$$\frac{\pi}{2} < \theta_1 < \theta_2 < \theta_3 < \pi$$

(D)

$$\pi > \theta_1 > \theta_2 > \theta_3 > \frac{\pi}{2}$$

CORRECT ANSWER: B

SOLUTION:

According to ascent formula for capillary tube.

$$H = \frac{2T\cos\theta}{\rho g r}$$

$$\therefore \frac{\cos\theta_1}{\rho_1} = \frac{\cos\theta_2}{\rho_2} = \frac{\cos\theta_3}{\rho_3}$$

Thus, $\cos\theta \propto \rho$

$$\therefore Rho_1 > \rho_2 > \rho_3$$

$\therefore \cos\theta_1 > \cos\theta_2$
$> \cos\theta_3$

$$0 \leq \theta_1 < \theta_2 < \theta_3 < \frac{\pi}{2}$$

Q-28 - 14527825

A block of density $2000kg/m^3$ and mass 10kg is suspended by a spring stiffness $100N/m$. The other end of the spring is attached to a fixed support. The block is completely submerged in a liquid of density $1000kg/m^3$. If the block is in equilibrium position.

(A) The elongation of the spring is 1 m

(B) the magnitude of buoyant force acting on the block is 25 N

(C) the spring potential energy is 12.5 J

(D) magnitude of spring force on the block is greater than the weight of the block

---

CORRECT ANSWER: C

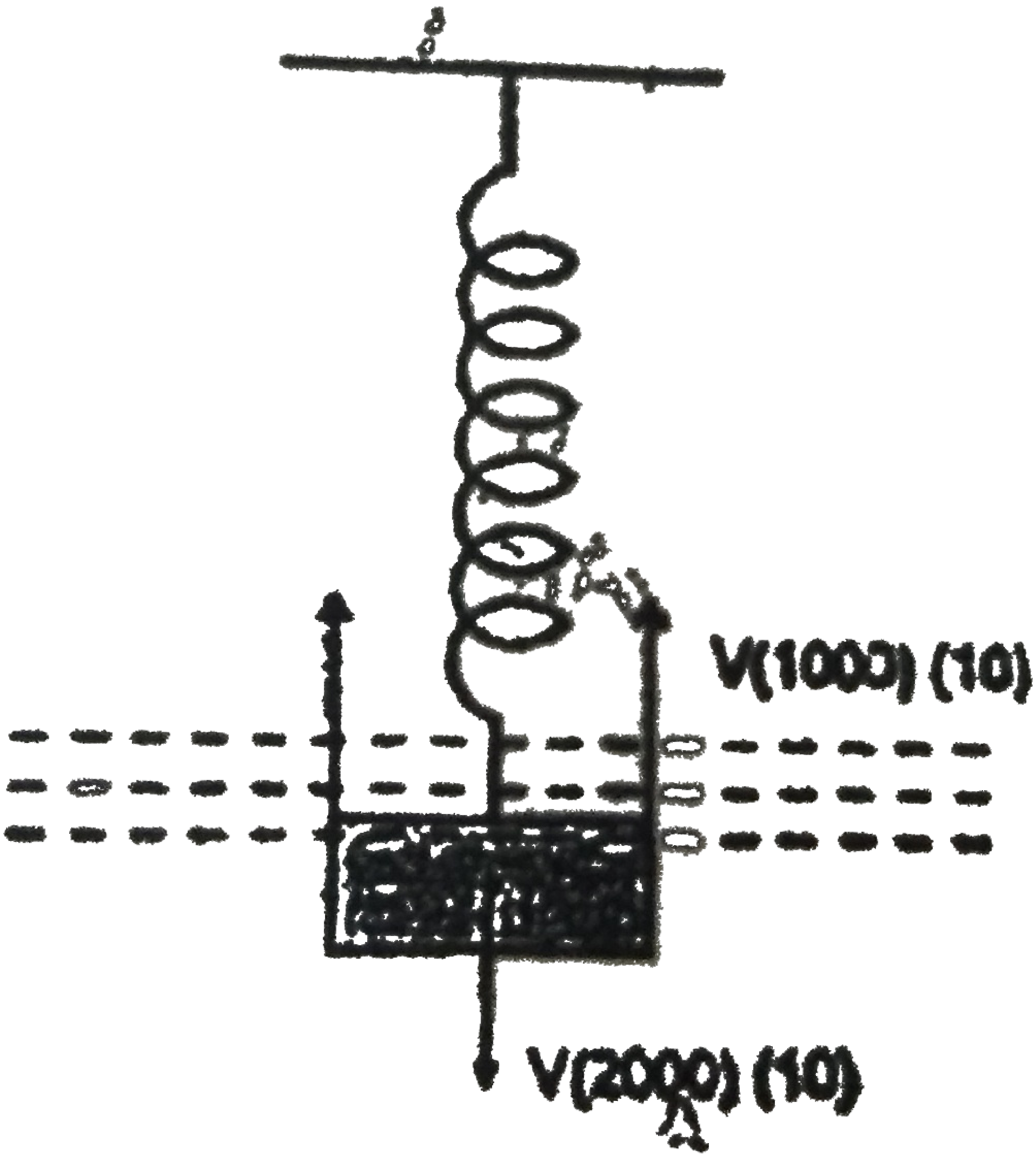
SOLUTION:

$$Kx = V(2000)(10) - V(1000)(10)$$

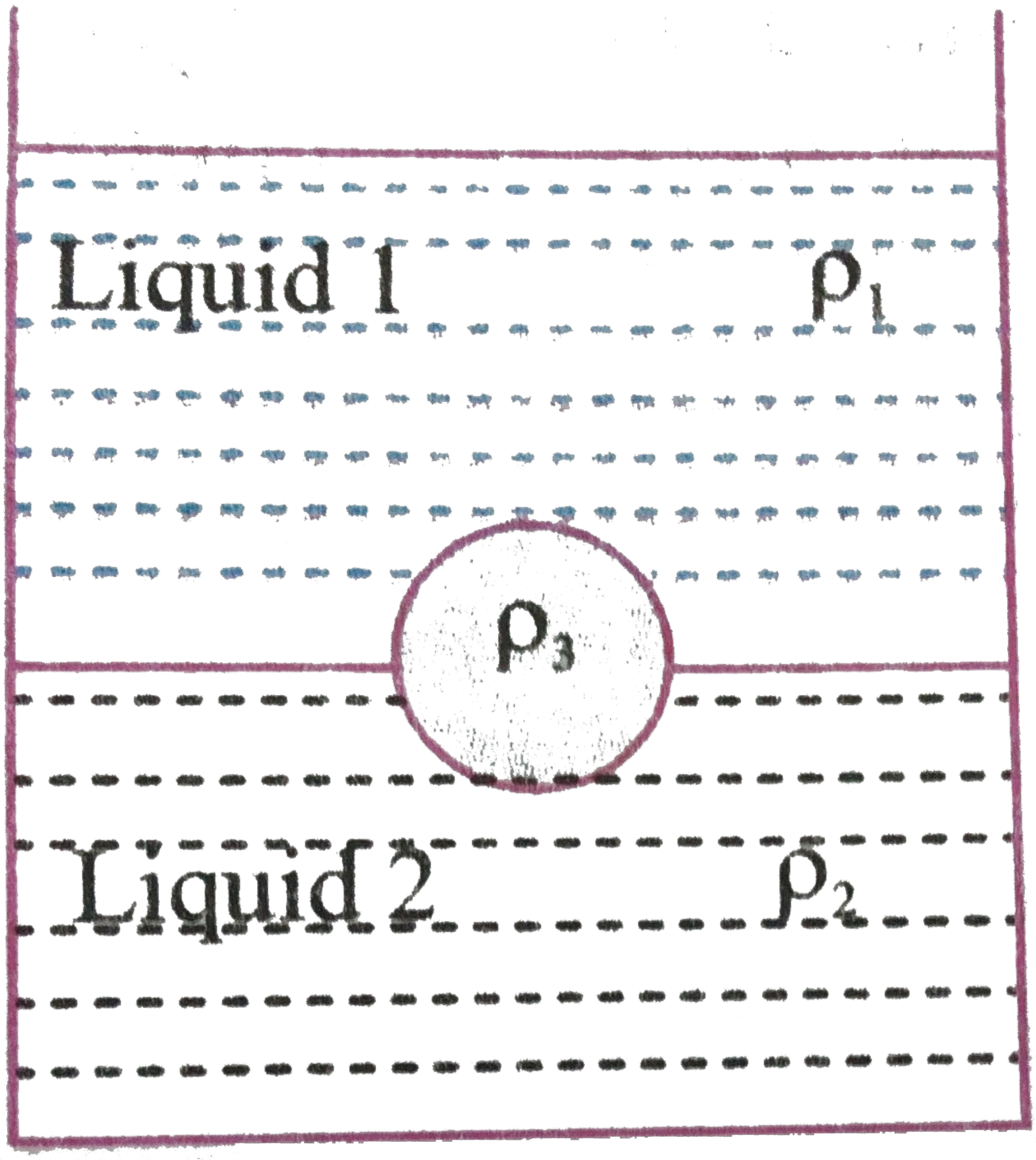
$$= \frac{10}{2000}[1000 \times 10]$$

Kx=50N ....(b)

$$U_{\text{Stored}} = \frac{1}{2} \times (100)\left(\frac{50}{100}\right)^2 = \frac{1}{2} \times \frac{2500}{100} = 12.5J$$



Q-29 - 13077276



A jar filled with two non-mixing liquid 1 and 2 having densities ρ_1 and ρ_2 respectively. A solid ball, made of a material of density ρ_3 is dropped in the jar. It come to equilibrium in the position shown in the figure. Which of the following is true for ρ_1, ρ_2 and ρ_3?

(A) $\rho_1 < \rho < \rho_3$

(B) $\rho_1 < \rho_3 < \rho_2$

(C) $\rho_3 < \rho_1 < \rho_2$

(D) $\rho_1 < \rho_3 < \rho_2$

CORRECT ANSWER: B

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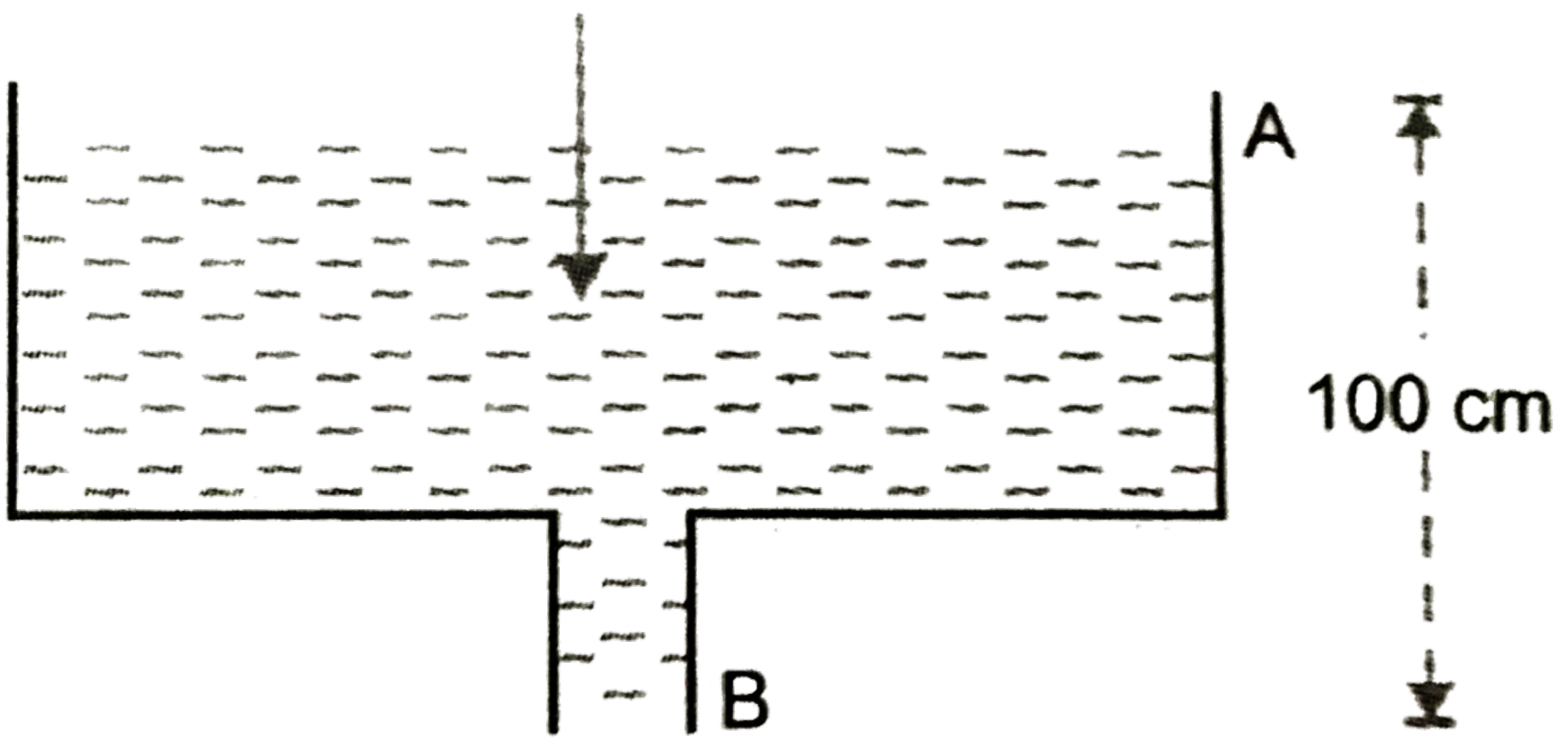
Q-30 - 12008508

Water flows through a vertical tube of varible cross-section. The area of cross-section at A and B 6 and 3 mm^2 respectively. If 12c c of water enters per second through A, find the pressure difference $P_A - P_B$. $\left(g = 10m / s^2\right)$. The separation between the cross-section at A and B is 100 cm.



(A) $1.6 \times 10^5 dyne / cm^2$

(B) $2.29 \times 10^5 dyne / cm^2$

(C) $5.9 \times 10^5 dyne / cm^2$

(D) $3.9 \times 10^5 dyne / cm^2$

CORRECT ANSWER: A

SOLUTION:

$$P_A - P_B = g(h_2 - h_1)\rho + \frac{1}{2}\rho\left(v_2^2 - v_1^2\right)$$

Volume of liquid flowing per second through A,

$$A_1 v_1 = 12 cm^3 / s$$

or

$$v_1 = \frac{12}{A_1}$$
$$= \frac{12cm^3/s}{6 \times 10^{-2}cm^2}$$
$$= 200cm/s$$

From equation of continuity,

$$A_1v_1 = A_2v_2$$

or

$$v_2 = \frac{A_1v_1}{A_2}$$
$$= \frac{12cm^3/s}{3 \times 10^{-2}cm^2}$$
$$= 400cm/s$$

.

$$h_2 - h_1 = 100cm$$
$$\therefore P_A - P_B = 1000$$
$$\times 100 \times 1 + \frac{1}{2} \times 1$$
$$\times \left[(400)^2 - (200)^2\right]$$

$$= 10^5 + \frac{1}{2} \times 12 \times 10^4$$

$$= 1.6 \times 10^5 dyne / cm^2$$

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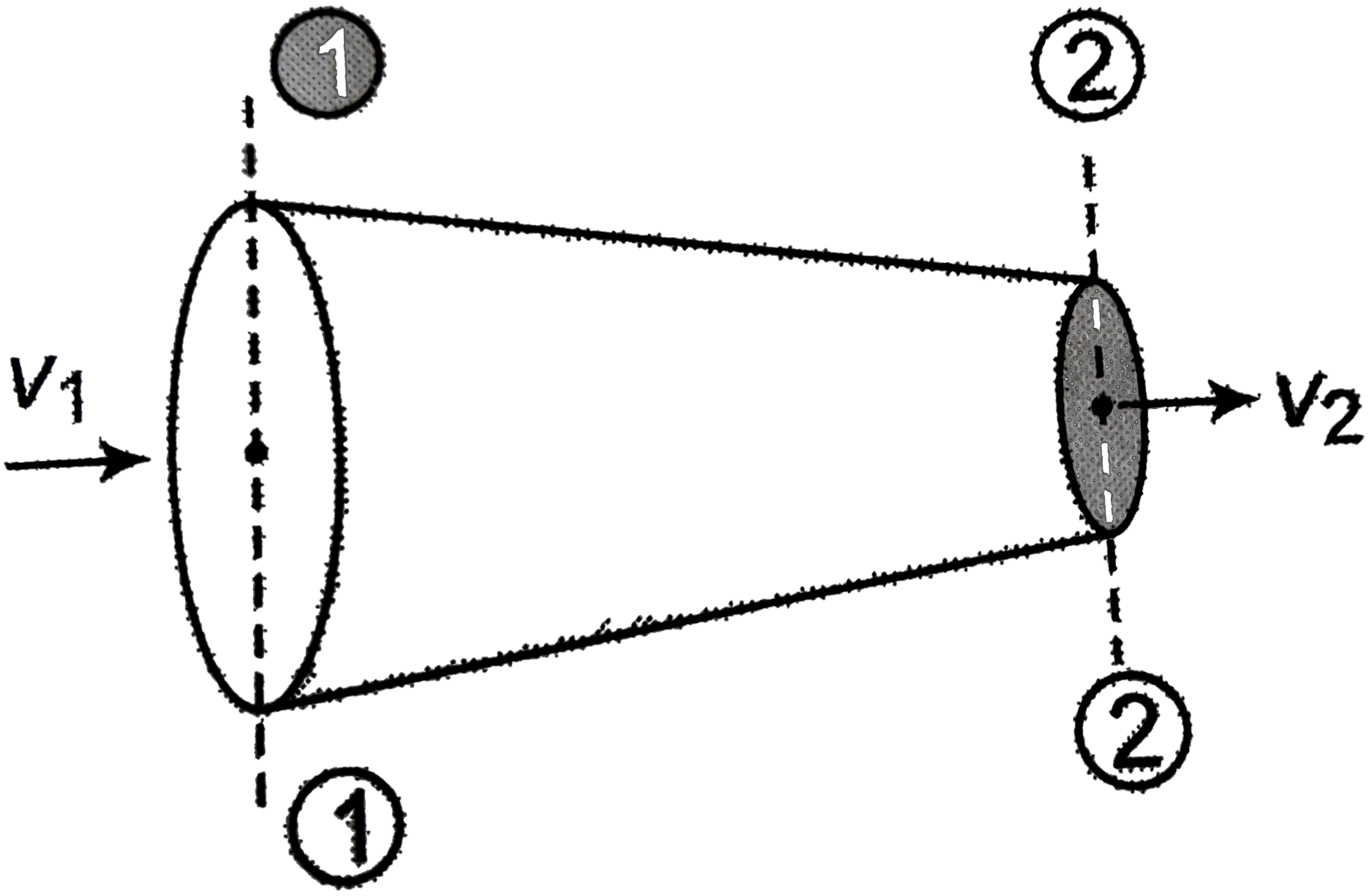
Q-31 - 13151685

Water is flowing steadily through a horizontal pipe of non-uniform cross-section. If the pressure of water is $4 \times 10^4 N / m^2$ at a point where cross-section is $0.02m^2$ and velocity of flow is $2m / s$. What is the pressure at a point where cross-section reduces to $0.01m^2$?



SOLUTION:

$P_1 = 4 \times 10^4 N/m^2,$

$a_1 = 0.02m^2, v_1 = 2m/s$

$P_2 = ?, a_2 = 0.01m^2,$
$v_2 = ?$

By continuity equation

$a_1 v_1 = a_2 v_2$

$0.02 \times 2 = 0.01 v_2$

$v_2 = 4m/s$

Applying Bernoulli's theorem

$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$$

$$P_2 = P_1 + \frac{1}{2}\rho\left(v_1^2 - v_2^2\right)$$

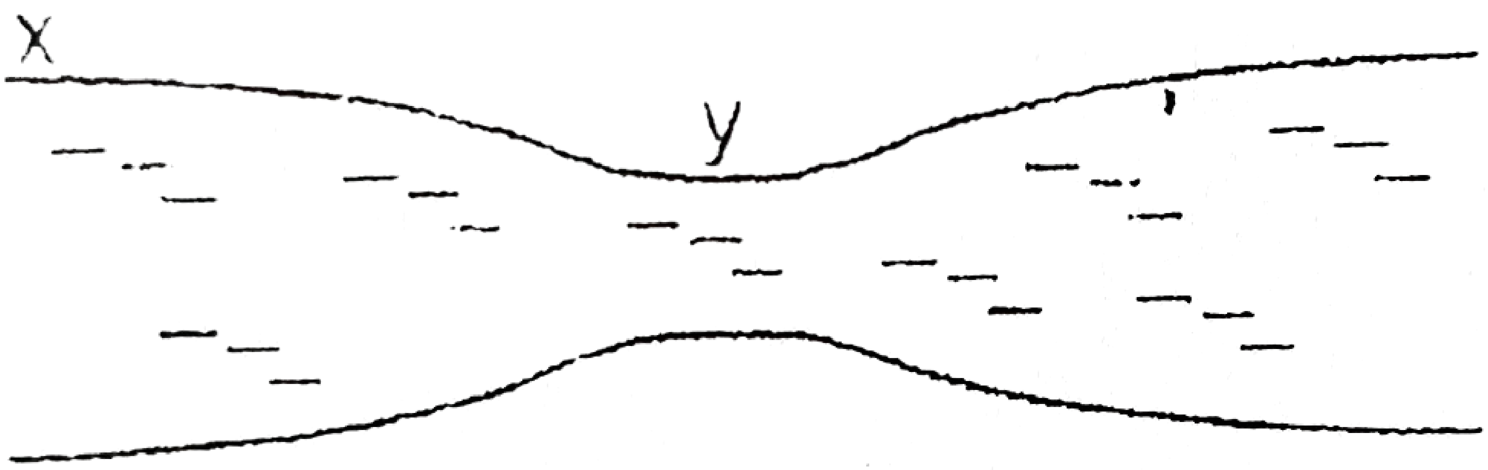
$$= 4 \times 10^4 + \frac{1}{2} \times 10^3\left(2^2 - 4^2\right)$$

$$= 4 \times 10^4 + \frac{1}{2} \times 10^3(6)(-2)$$

$=3.4 \times 10^4 N/m^2$.

Q-32 - 15601767

Water flows in a horizontal tube as shown in figure. The pressure of water changes by $600N/m^2$ between x and y where the areas of cross-section are $3cm^2$ and $1.5cm^2$ respectively. Find the rate of flow of water through the tube.



SOLUTION:

Let the velocity at $x = v_x$ and that at $y = v_y$.

By the equation of continuity, $\frac{v_y}{v_x} = \frac{3cm^2}{1.5cm^2} = 2.$

By Bernoulli's equation,

$$P_x + \frac{1}{2}\rho v_x^2 = P_y$$

$$+ \frac{1}{2}\rho v_y^2$$

or,

$$P_x - P_y = \frac{1}{2}\rho\left(2V_y\right)^2$$

$$- \frac{1}{2}\rho v_y^2 = \frac{3}{2}\rho V_y^2$$

or,

$$600\frac{N}{m^2}$$

$$= \frac{3}{2}\left(1000\frac{kg}{m^3}\right)v_x^2$$

or,

$$v_x = \sqrt{0.4m^2/s^2}$$

$$= 0.63m/s$$

.

The rate of flow

$$= (3cm^2)(0.63m / s)$$
$$= 189cm^3 / s$$

.

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Q-33 - 17092131

Water is flowing through two horizontal pipes of different diameters which are connected together. In the first pipe the speed of water 4 m/s and the pressure is $2.0 \times 10^4 N / m^2$. Calculate the speed and pressure of water in the second pipe. The diameter of the pipes the diameter of the pipes are 3 cm and 6 cm respectively.

CORRECT ANSWER: $2.75XX10^4 N / M^2$

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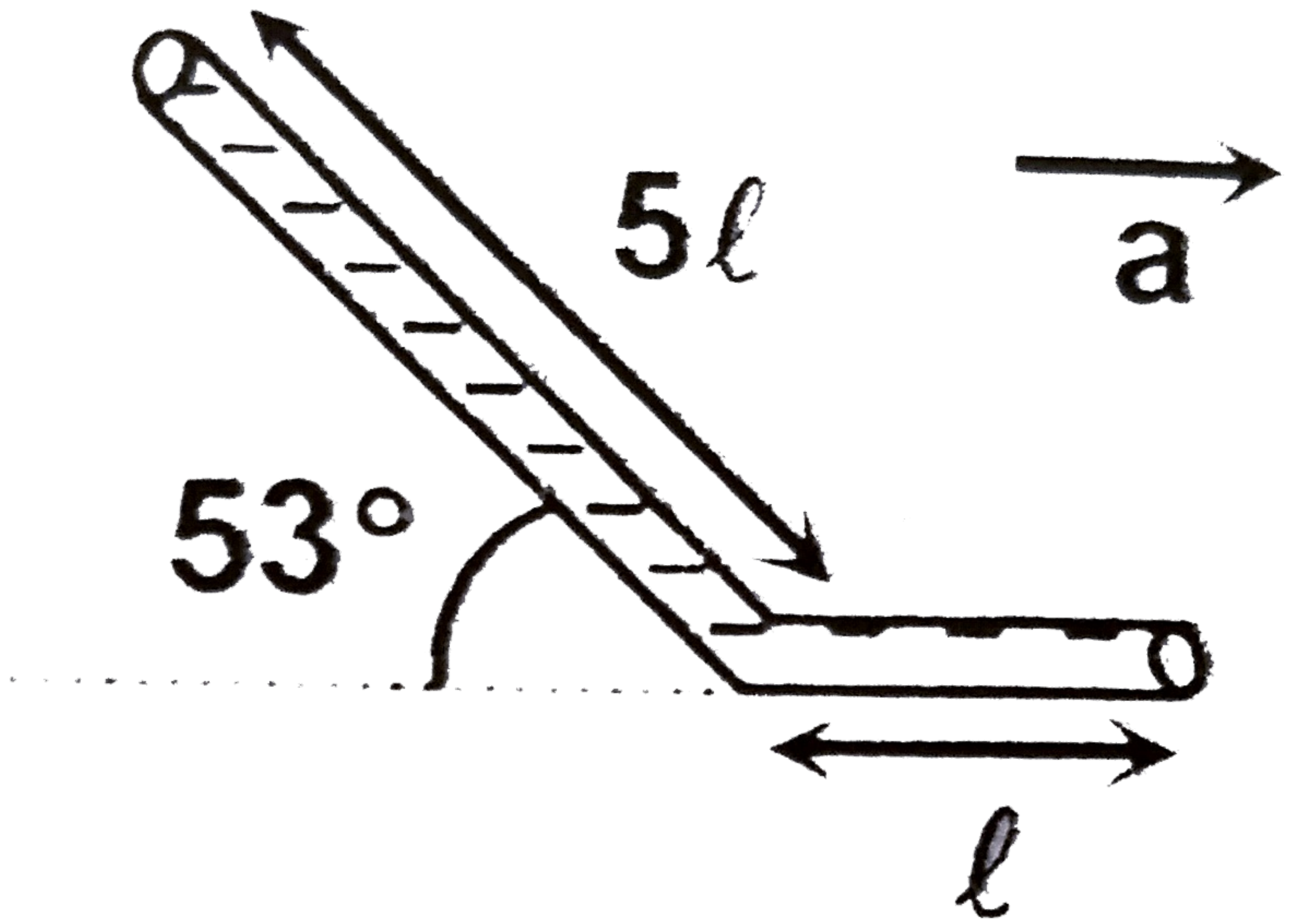
Q-34 - 14278117

In the given tube liquid density ρ is filled. Find the acceleration of the tuve towards right direction such that no liquid will fall out of the tube.



(A) $\frac{3}{5}g$

(B) $\frac{4}{5}g$

(C) g

(D) $4g$

CORRECT ANSWER: C

SOLUTION:

$$\tan\theta = \frac{4l}{4l} = \frac{a}{g}$$

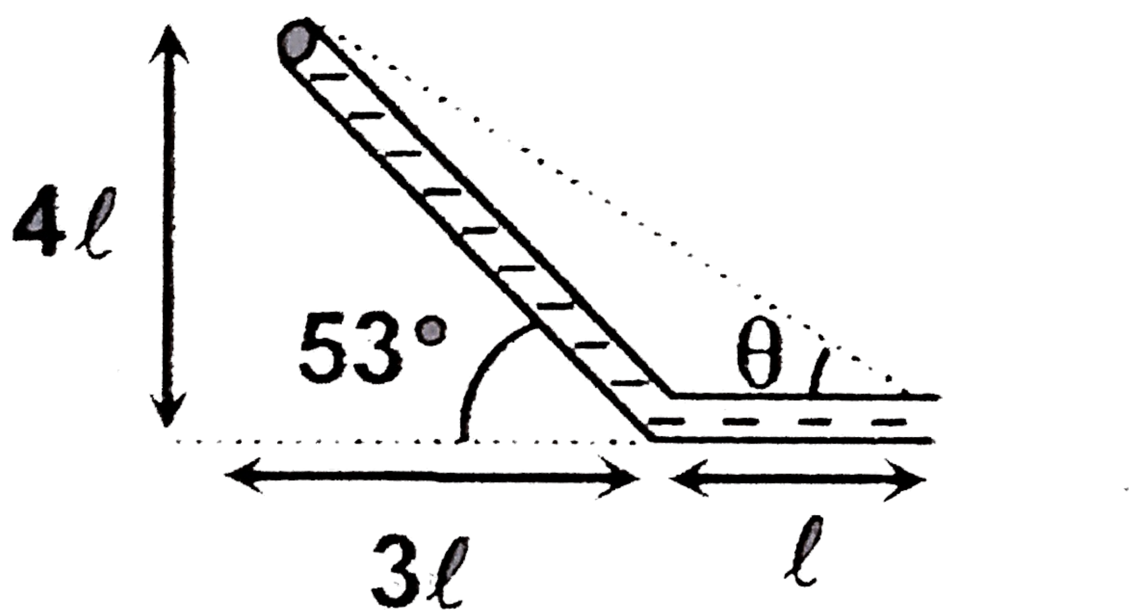
$$\Rightarrow a = g$$

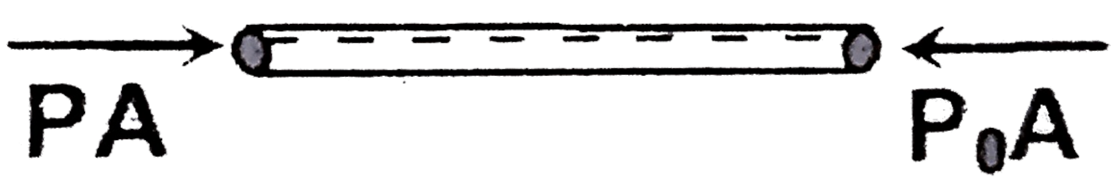
Or, $PA - P_0A = (\rho l A)a$

$$(5l)(\rho A)\left(g\frac{4}{5} - \frac{3}{5}a\right)$$

$$= \rho l \rho a$$

$a = g$





Q-35 - 15822257

A liquid is coming out from a vertical tube. The relation between the weight of the drop W , surface tension of the liquid T and radius of the tube r is given by, if the angle of contact is zero

(A) $W = \pi r^2 T$

(B) $W = 2\pi r T$

(C) $W = 2r^2 \pi T$

(D) $W = \frac{3}{4}\pi r^3 T$

CORRECT ANSWER: B

Q-36 - 10058895

A large open tank has two holes in the wall. One is a square hole of side L at a depth y from the top and the other is a circular hole of radius R at a depth 4y from the top. When the tank is completely filled with water, the quantities of water flowing out per second from both holes are the same. Then, R is equal to

(A) (a) $\frac{L}{\sqrt{2\pi}}$

(B) (b) $2\pi L$

(C) (c) L

(D) (d) $\frac{L}{2\pi}$

CORRECT ANSWER: A

SOLUTION:

Equating the rate of flow, we have

$$\sqrt{(2gy)} \times L^2$$
$$= \sqrt{(2g \times 4y)}\pi R^2$$

[Flow=(area)xx(velocity), velocity= $\sqrt{2gx}$]

where x=height from top

$$\Rightarrow L^2 = 2\pi R^2 \Rightarrow R = \frac{L}{\sqrt{2\pi}}$$

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Q-37 - 11796641

A water tank of height H, completely filled with water is placed on a level ground. It has two holes one at a depth h from top and the other at height h form its base. The water ejecting from both holes

(A) both the holes will fall at the same spot

(B) upper hole will fall farther than that form the lower hole

(C) upper hole will fall closer than that form the lower

hole

(D) more information is required.

CORRECT ANSWER: A

SOLUTION:

Velocity of water coming out from hole A

v_(1) = sqrt(2gh)

$Velocityofwaterco$

$\min goutomho \leq B$

=v_(2)=sqrt(2g(H-h))

$Timetakenbywater$

$\rightarrow reachthegroundomho$

$\leq$

A=t_(1) = sqrt(2(H-h)//g)

$Timetakenbywater$

$\rightarrow reachthegroundomho$

$\leq$

B=t_(2) = sqrt(2h//g)

$Obviously, ran$

$\geq ontheground f$ or

$\perp histhesame$

:. R = v_(1)t_(1) = v_(2)t_(2) = 2gsqrt(h(H-h))`.

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Q-38 - 10058899

Water is filled in a container upto height 3m. A small hole of area 'a' is punched in the wall of the container at a height 52.5 cm from the bottom. The cross sectional area of the container is A. If $a/A = 0.1$ then v^2 is (where v is the velocity of water coming out of the hole)

(A) (a) 50

(B) (b) 51

(C) (c) 48

(D) (d) 51.5

CORRECT ANSWER: A

SOLUTION:

The square of the velocity of efflux

$$v^2 = \frac{2gh}{\sqrt{1-\left(\frac{a}{A}\right)^2}} \text{ or, }$$

$$v^2 = \frac{2 \times 10 \times 2.475}{\sqrt{1-(0.1)^2}}$$

$$= 50m^2/s^2$$

$$h = 3 - 0.525$$

$$= 2.47m$$

Q-39 - 13077175

A stress of $10^6 N/m^2$ is required for breaking a material. If the density of the material is $3 \times 10^3 Kg/m^3$, then what should be the minimum length of the wire made of the same material so that it breaks by its own weight $(g = 10m/s^2)$

(A) $33.4m$

(B) $3.4m$

(C) $34cm$

(D) $3.4cm$

CORRECT ANSWER: A

SOLUTION:

$$e = \frac{l^2 dg}{2Y}$$

Q-40 - 12008270

Water rises to a height of 10 cm. in a certain capillary tube. If in the same tube, level of Hg is depressed by 3.42 cm., compare the surface tension of water and mercury. Sp. Gr. Of Hg is 13.6 the angle of contact for water is zero and that for Hg is $135^{\cdot}$

CORRECT ANSWER: 0.152

SOLUTION:

Let S_1, S_2 be the surface tension of water and mercury respectively. Let h be the height of water raised due to S.T. and h_2 the depression of mercury. Then

$h_1 = 10cm, h_2 = -3.42cm.$

Angle of contant for water and capillary tube, $\theta_1 = 0$

and for mercury and capillary tube, $\theta_2 = 135^{\cdot}$

$$h_1 = \frac{2S_1 \cos\theta_1}{r\rho_1 g} \text{ and}$$

$$h_2 = \frac{2S_2 \cos\theta_2}{r\rho_2 g}$$

$$\therefore \frac{h_1}{h_2} = \frac{S_1 \cos \theta_1 \rho_2}{S_2 \cos \theta_2 \rho_1}$$

$$\text{or } \frac{S_1}{S_2} = \frac{h_1 \rho_1 \cos \theta_2}{h_2 \rho \cos \theta_1}$$

$$\text{or } \frac{S_1}{S_2}$$

$$= \frac{10 \times 1 \times \cos 135^{\square}}{(-3.42) \times 13.6 \times \cos 0^{\square}}$$

$$= \frac{10 \times (-0.7071)}{(-3.42) \times 13.6}$$

$$= 0.152$$

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Q-41 - 11302374

A long elastic spring is stretched by $2cm$ and its potential energy is U. If the spring is stretched by $10cm$, the PE will be

(A) $5U$

(B) $25U$

(C) $U/5$

(D) $U/20$

CORRECT ANSWER: B

SOLUTION:

The elastic potential is

Energy $= \frac{1}{2}\text{Stress} \times \text{Strain}$

$= \frac{1}{2}Y(\text{strain})^2$

$= \frac{1}{2}Y\left(\frac{\triangle l}{L}\right)^2$

$\therefore \frac{U_2}{U_1} \propto \left(\frac{\triangle l_2}{\triangle l_2}\right)^2$

$= \left(\frac{10}{2}\right)^2$

$$\frac{U_2}{U_1} = 25 \Rightarrow u_2 = 25U_1$$

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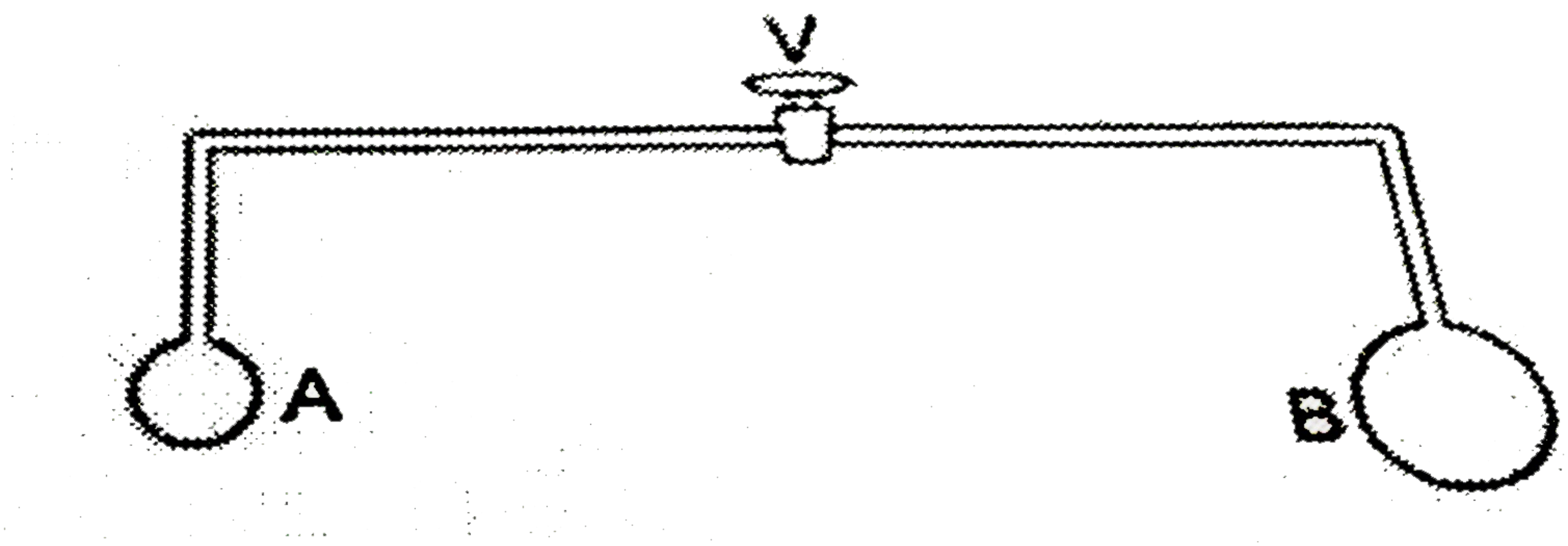
Q-42 - 16978782



The value V in the bent tube is initially kept closed. Two soap bubbles A (smaller) and B (larger) are formed at the two open ends of the tube. V is now opened, and air can flow freely between the bubbles.

(A) There will be no change in the sizes of the bubbles.

(B) The bubbles will become of equal size.

(C) A will become smaller and B will become larger.

(D) The sizes of the two bubbles will become interchanged.

CORRECT ANSWER: C

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Q-43 - 10964980

Two unequal soap bubbles are formed one on each side of a tube closed in the middle by a tap. What happens when the tap is opened to put the two bubbles in communication?

(A) No air passes in any direction as the pressures are the same on two sides of the tap

(B) Larger bubble shrinks and smaller bubble increases in size till they bexome equal in size

(C) Smaller bubble gradually collapses and the bigger one increases in size

(D) None of the above

CORRECT ANSWER: C

SOLUTION:

Pressure inside a soap bubble is given by,

$P = P_0 + \frac{4T}{r}$ ltbRgt So, pressure inside a smaller soap bubble will be more and air will flow from smaller drop to bigger drop.

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Q-44 - 11748907

Eight frops of water, each of radius $2mm$ are falling through air at a terminal velcity of $8cms^{-1}$. If they coalesce to form a single drop, then the terminal velocity of combined drop will be

(A) $32 cms^{-1}$

(B) $30 cms^{-1}$

(C) $28 cms^{-1}$

(D) $24 cms^{-1}$

CORRECT ANSWER: A

SOLUTION:

Let the radius of bigger drop is R is smaller drop is r

then
$\frac{4}{3}\pi R^3 = 8 \times \frac{4}{3}$
$\times \pi R^3$

or $R = 2r, (i)$

Terminal velocity, $c \propto r^2$

$$\therefore \frac{v'}{v} = \frac{R^2}{r^2}$$

$$= \left(\frac{2r}{r}\right)^2 = 4$$

or

$$v' = 4c = 4 \times 8$$

$$= 32cms^{-1}$$

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Q-45 - 11302530

n drops of water, each of radius $2mm$, fall through air at a terminal velocity of $8cm^{-1}$ If they coalesce to form a single drop, then the terminal velocity of the combined drop is $32cm^{-1}$ The value of n is

CORRECT ANSWER: 8

SOLUTION:

$$\frac{4}{3}\pi R^3 = n \times \frac{4}{3}\pi r^3$$

or $R^3 = nr^3$ or $R = n^{1/3}r$

or $R = 2\pi^{1/3}mm$

$v_0 \propto r^2, v_0' \propto R^2$

Now $\frac{v_0'}{v_0} = \frac{R^2}{r^2} = \frac{4n^{2/3}}{4}f$

or $\frac{32}{8} = n^{2/3}$ or $n^{2/3} = 4$

or $n = 4^{3/2} = \sqrt{64}$

or $n = 8$

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Q-46 - 10058944

A $0.1kg$ mass is suspended from a wire of negligible mass. The length of the wire is 1m and its crosssectional are is $4.9 \times 10^{-7}m^2$. If the mass is pulled a little in the vertically downward direction and released, it performs simple harmonic motion of angular frequency $140rads^{-1}$. If the Young's modulus of the material of the wire is

$n \times 10^9 Nm^{-2}$, the value of n is

CORRECT ANSWER: D

SOLUTION:

We know that $\omega = \sqrt{\frac{K}{m}}$ (i)

Here

$$Y = \frac{FL}{Al} \Rightarrow F$$
$$= \left(\frac{YA}{L}\right) l$$

Comparing the above equation with $F = kl$ we get

$K = \left(\frac{YA}{L}\right)$ (ii)

From (i) & (ii), $\omega = \sqrt{\frac{YA}{ml}}$

$$\therefore 140$$
$$= \sqrt{\frac{n \times 10^9 \times 4.9 \times 10^{-7}}{0.1 \times 1}}$$
$$\therefore n = 4$$

Q-47 - 14160257

if ρ is the density of the meterial of a wire and σ is the breaking stress. The greatest length of the wire that can hang freely without breaking is

(A) $\frac{2\sigma}{\rho g}$

(B) $\frac{\rho}{\sigma g}$

(C) $\frac{\rho g}{2\sigma}$

(D) $\frac{\sigma}{\rho g}$

CORRECT ANSWER: D

SOLUTION:

Maximum stress on the wire will be at highest point (at the point of suspension)

$$\therefore stress = \frac{\text{weight}}{A}$$

$$= \frac{Al\rho g}{A} = \sigma$$

$$\therefore l = \frac{\sigma}{\rho g}$$

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Q-48 - 12007297

The density of a metal at normal pressure is ρ. Its density when it is subjected to an excess pressure p is ρ' . If B is the bluk modulus of the metal, then find the ratio ρ' / ρ.

SOLUTION:

Bulk modulus ,

$$B = \frac{p}{dV / V} \text{ or } dV$$

$$= \frac{pV}{B}$$

When pressure is increased, the volume will decrease.

therefore, $\rho = \frac{M}{V}$

and

$$\rho' = \frac{M}{V - dV}$$

$$= \frac{M}{V - (pV / B)}$$

or

$$\rho' = \frac{M}{V(1 - p / B)}$$

$$= \frac{\rho}{(1 - p / B)}$$

or

$$\rho' = \frac{1}{1 - P/b}$$

$$= (1 - p/B)^{-1}$$

$$= \left(1 + \frac{p}{B}\right)$$

.

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Q-49 - 10058918

A point mass m is suspended at the end of a massless wire of length l and cross section. If Y is the Young's modulus for the wire, obtain the frequency of oscillation for the simple harmonic motion along the vertical line.

CORRECT ANSWER: A::B

SOLUTION:

From fig. (b), due to equilibrium

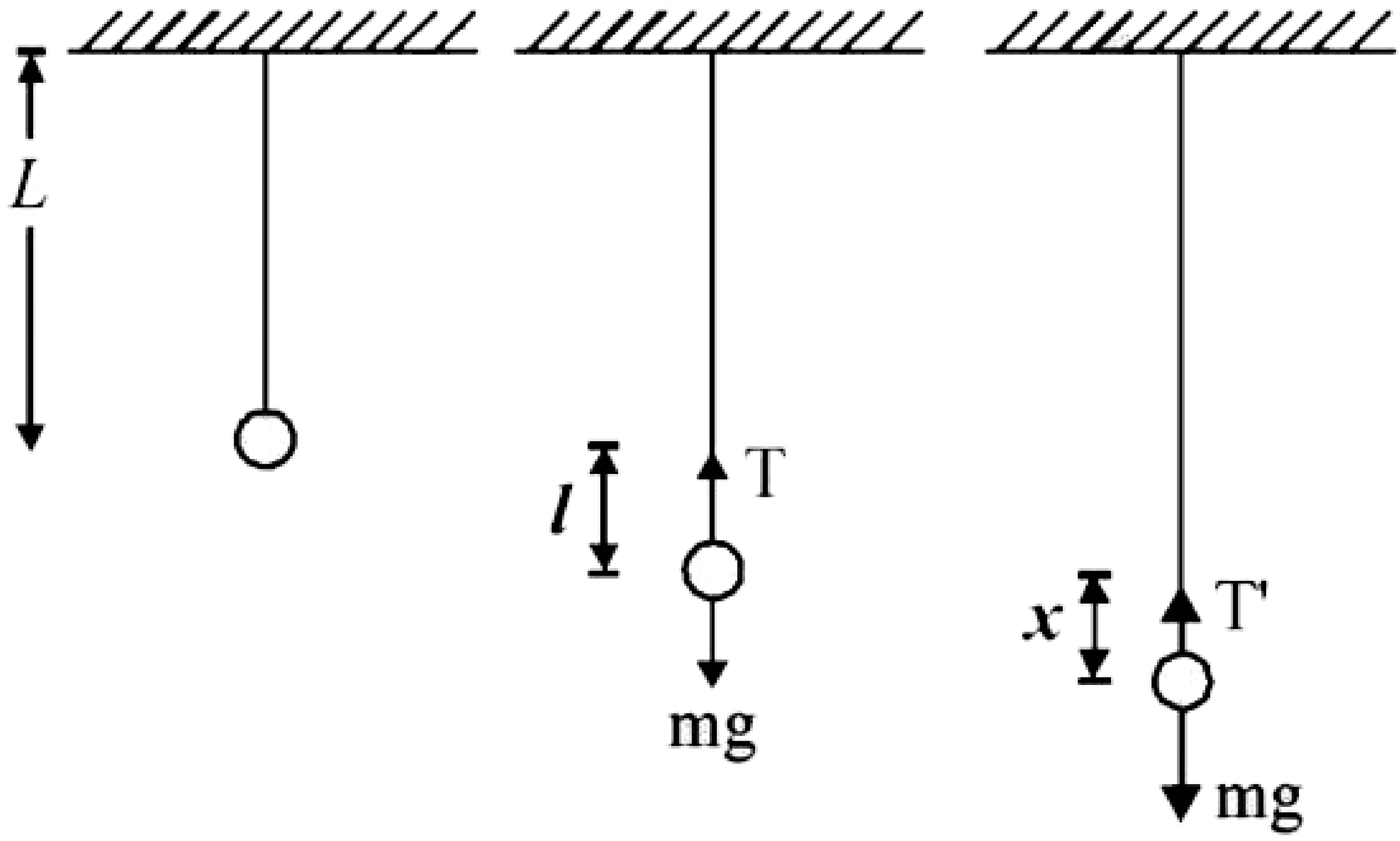
$T = mg$ (i)

But $Y = \dfrac{T/A}{l/L}$

$\Rightarrow T = \dfrac{YAl}{L}$ (ii)

From (i) and (ii)

$mg = \dfrac{YAl}{L}$ (iii)



From fig. (c)

Restoring force

$= -\left[T' - mg\right] =$

$-\left[\dfrac{YA(l+x)}{L}\right.$

$\left.-\dfrac{YAl}{L}\right]$

[from (iii)]

$$= \frac{-YAx}{L}$$

On comparing this equation with $F = -m\omega^2 x$, we get

$$m\omega^2 = \frac{YA}{L} = \omega$$

$$= \sqrt{\frac{YA}{mL}} \Rightarrow \frac{2\pi}{T}$$

$$= \sqrt{\frac{YA}{mL}}$$

Frequency $f = \frac{1}{T} = \frac{1}{2\pi}\sqrt{\frac{YA}{mL}}$

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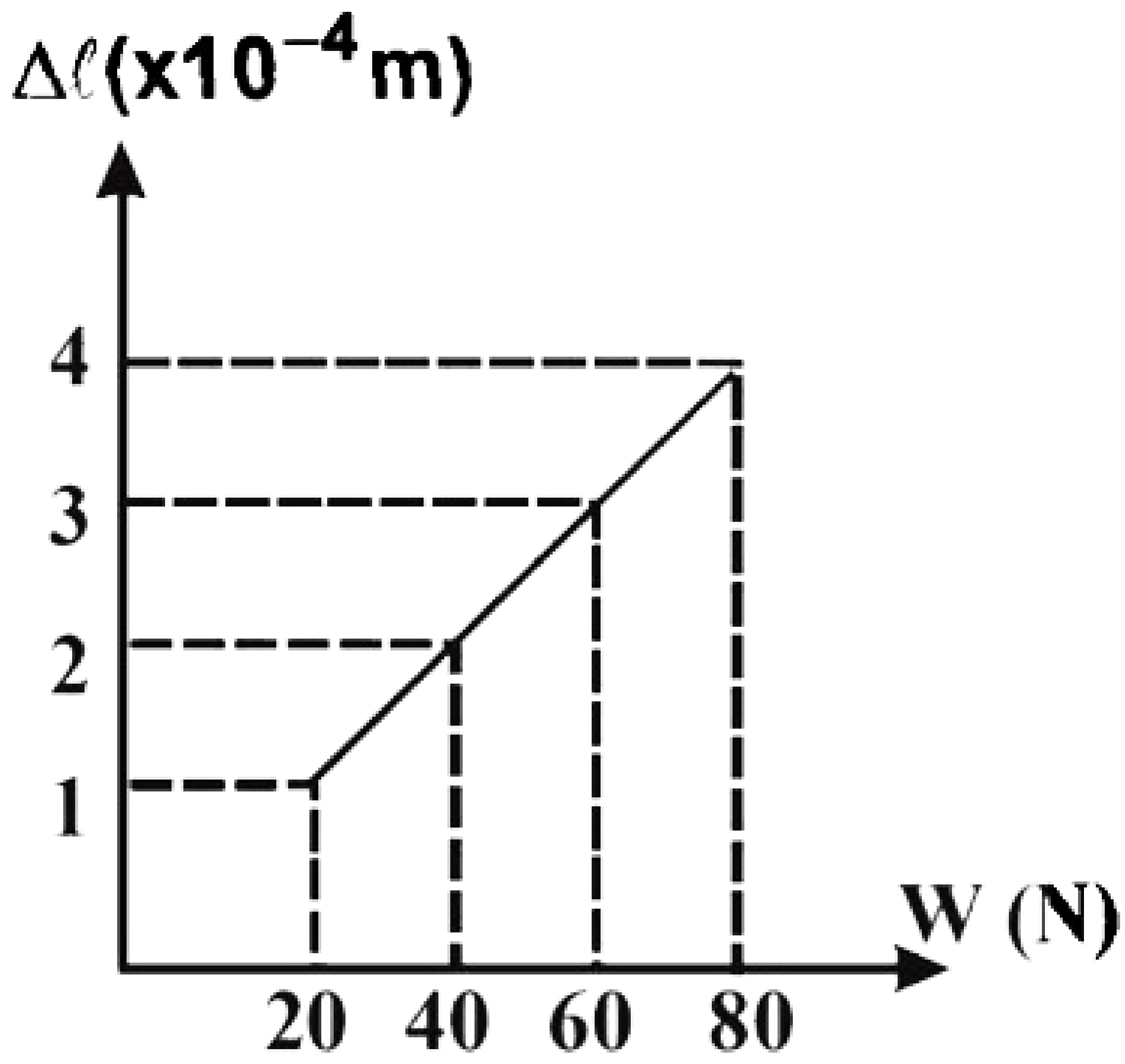
Q-50 - 10058898

The adjacent graph shows the estension (Δl) of a wire of length 1m suspended from the top of a roof at one end and with a load W connected to the other end. If the cross-sectional area of the wire is $10^{-6} m^2$, calculate the Young's modulus of the material of the wire.



(A) (a) $2 \times 10^{11} N / m$

(B) (b) $2 \times 10^{-11} N / m$

(C) (c) $3 \times 10^{-12} N / m$

(D) (d) $2 \times 10^{-13} N / m$

CORRECT ANSWER: A

SOLUTION:

$$Y = \frac{F}{A} / \frac{\Delta l}{l} = \frac{F}{A}$$

$$\cdot \frac{l}{\Delta l} = \frac{20 \times 1}{10^{-6} \times 10^{-4}}$$

$$= 2 \times 10^{11} N / m^2$$

Q-51 - 17666347

A bucket water filled upto a height = 15 cm. The bucket is tied to a rope which is passed over a frictionless light pulley and the other end of the rope is tied to a weight of mass which is half of that of the (bucket + water). The water pressure above atmospheric pressure at the bottom is

(A) 0.5 kPa

(B) 1 kPa

(C) 5kPa

(D) None of these

CORRECT ANSWER: B

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Q-52 - 13077389

A bucket containing water of depth 15 cm is kept in a lift which is moving vertically upward with an acceleration 2g. Then the pressure on the bottom of the bucket in $kgwt / cm^2$ is

(A) 0.45

(B) 0.045

(C) 0.015

(D) 0.15

CORRECT ANSWER: B

SOLUTION:

$$P = hd(g + a)$$

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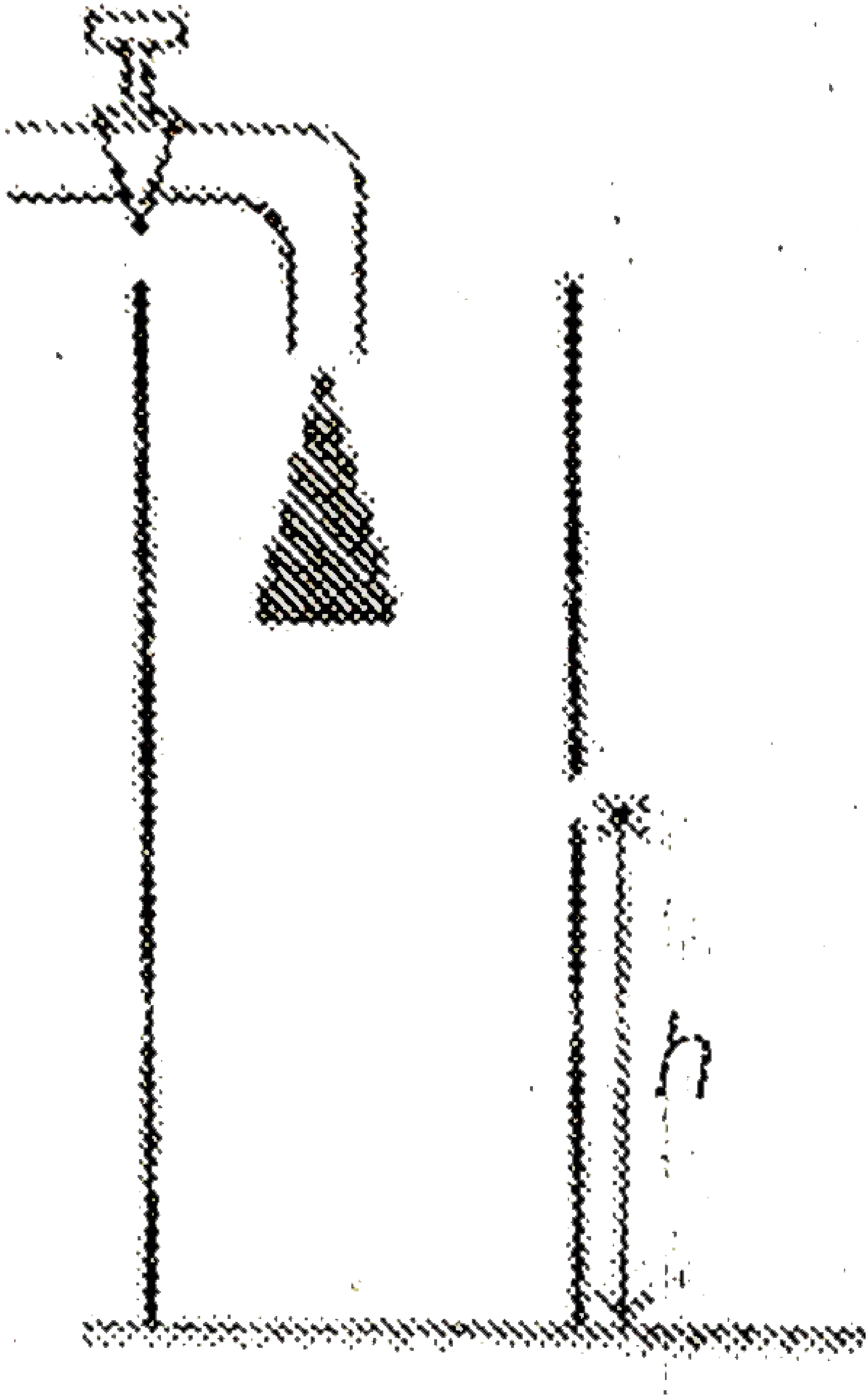
Q-53 - 17666364

The diagram shows a tall cylindrical container kept on a horizontal surface. From a tap, water come with constant rate qm^3 / s. Initially the container was empty. An orifice of area of cross section A is made at some height h in the side wall of the container. If the horizontal range of the water jet in steady is found to be 2h, then the relation between h and q is



(A) $h = \dfrac{q^2}{gA^2}$

(B) $h = \frac{q^2}{2gA^2}$

(C) $h = \frac{3q^2}{2gA^2}$

(D) $h = \frac{2q^2}{gA^2}$

CORRECT ANSWER: B

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Q-54 - 10058899

Water is filled in a container upto height 3m. A small hole of area 'a' is punched in the wall of the container at a height 52.5 cm from the bottom. The cross sectional area of the container is A. If $a / A = 0.1$ then v^2 is (where v is the velocity of water coming out of the hole)

(A) (a) 50

(B) (b) 51

(C) (c) 48

(D) (d) 51.5

CORRECT ANSWER: A

SOLUTION:

The square of the velocity of efflux

$v^2 = \frac{2gh}{\sqrt{1 - \left(\frac{a}{A}\right)^2}}$ or,

$v^2 = \frac{2 \times 10 \times 2.475}{\sqrt{1 - (0.1)^2}}$

$= 50m^2 / s^2$

$h = 3 - 0.525$

$= 2.47m$

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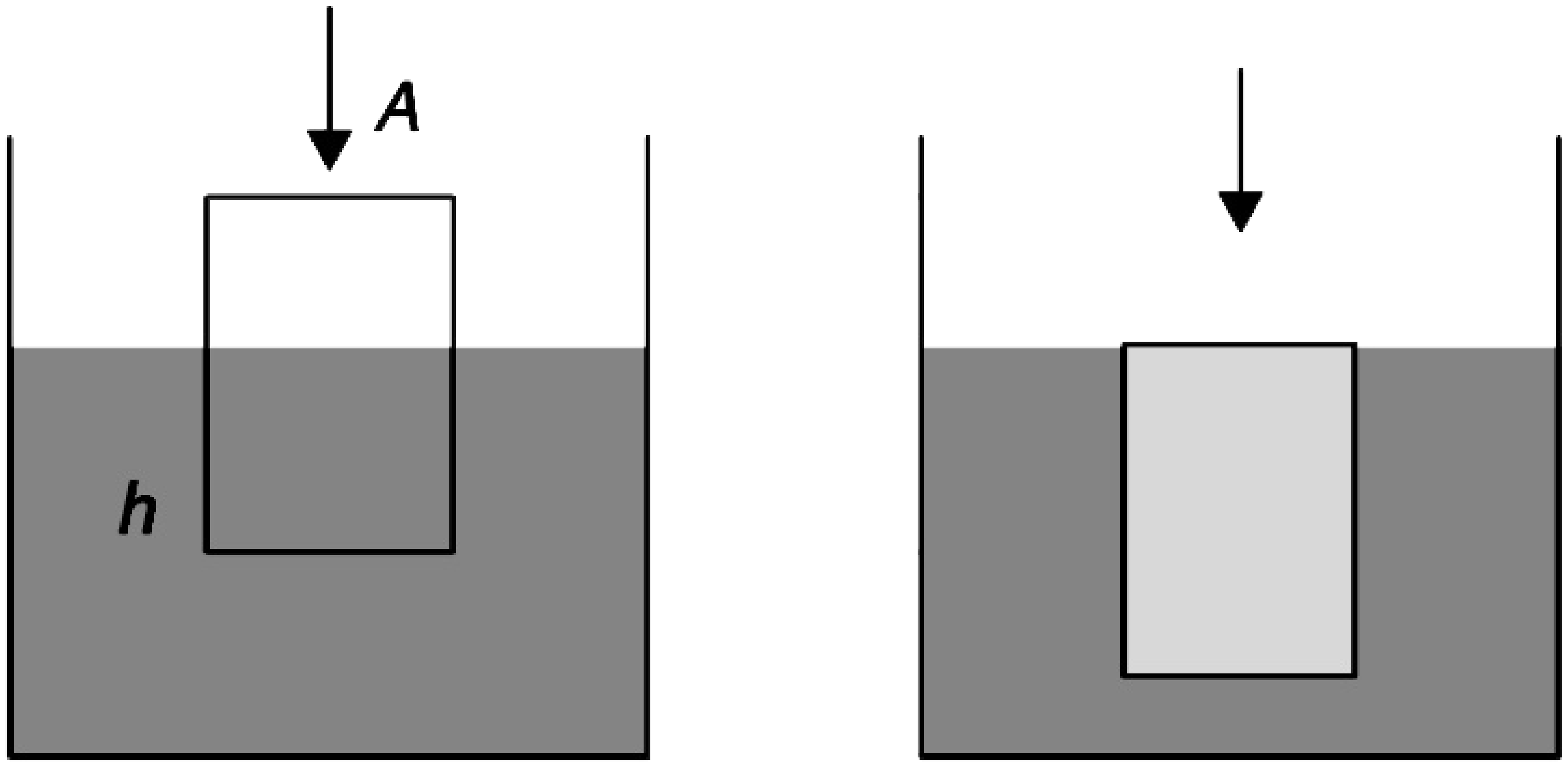
Q-55 - 15085425

A cylindrical wooden block of density half the density of water is floating in water in a cylindrical container. The cross section of the wooden block. And its height are A and h respectively. The cross sectional area of the container is 2A. The wooden block is pushed vertically so that it gradually gets immersed in water. Calculate the amount of work done in pushing the block. Density of water $= \rho_0$.



CORRECT ANSWER: $W = \frac{1}{16} ARHO_0 GH^2$

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Q-56 - 10964912

Liquid is filled in a container upto a height of H. A small hle is made at the bottom of the tank. Time taken to empty from H to $\frac{H}{3}$ is t_0. Find the time taken to empty tank from $\frac{H}{3}$ to zero.

CORRECT ANSWER: A::C

SOLUTION:

$$t = \frac{A}{a}\sqrt{\frac{2H}{g}}$$ (to empty the complete tank)

Now,

$$t_{H \to o} = t_{H \to \frac{H}{3}} + t$$

$$\xrightarrow[3]{H} 0$$

Given,

$$\frac{A}{a}\sqrt{\frac{2H}{g}} = t_0$$

$$+ \frac{A}{a}\sqrt{\frac{2H/3}{g}}$$

from here find,

$$\frac{A}{a}\sqrt{\frac{2H/3}{g}}.$$

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Q-57 - 17666313

A glass tube $80cm$ long and open ends is half immersed in mercury. Then the top of the tube is closed and it is taken out of the mercury. A column of murcury $20cm$ long then remains in the tube. The atmospheric (in cm of Hg) is

(assume temperature to be constant)

(A) 75

(B) 30

(C) 60

(D) 90

CORRECT ANSWER: C

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Q-58 - 10058969

An open glass tube is immersed in mercury in such a way that a lenth of 8cm extends above the mercury level. The open end of the tube is then closed and sealed and the tube is raised vertically up by additional 46cm. What will be length of the air column above mercury in the tube now?

(Atmosphere pressure =76cm of Hg)

(A) (a) 16cm

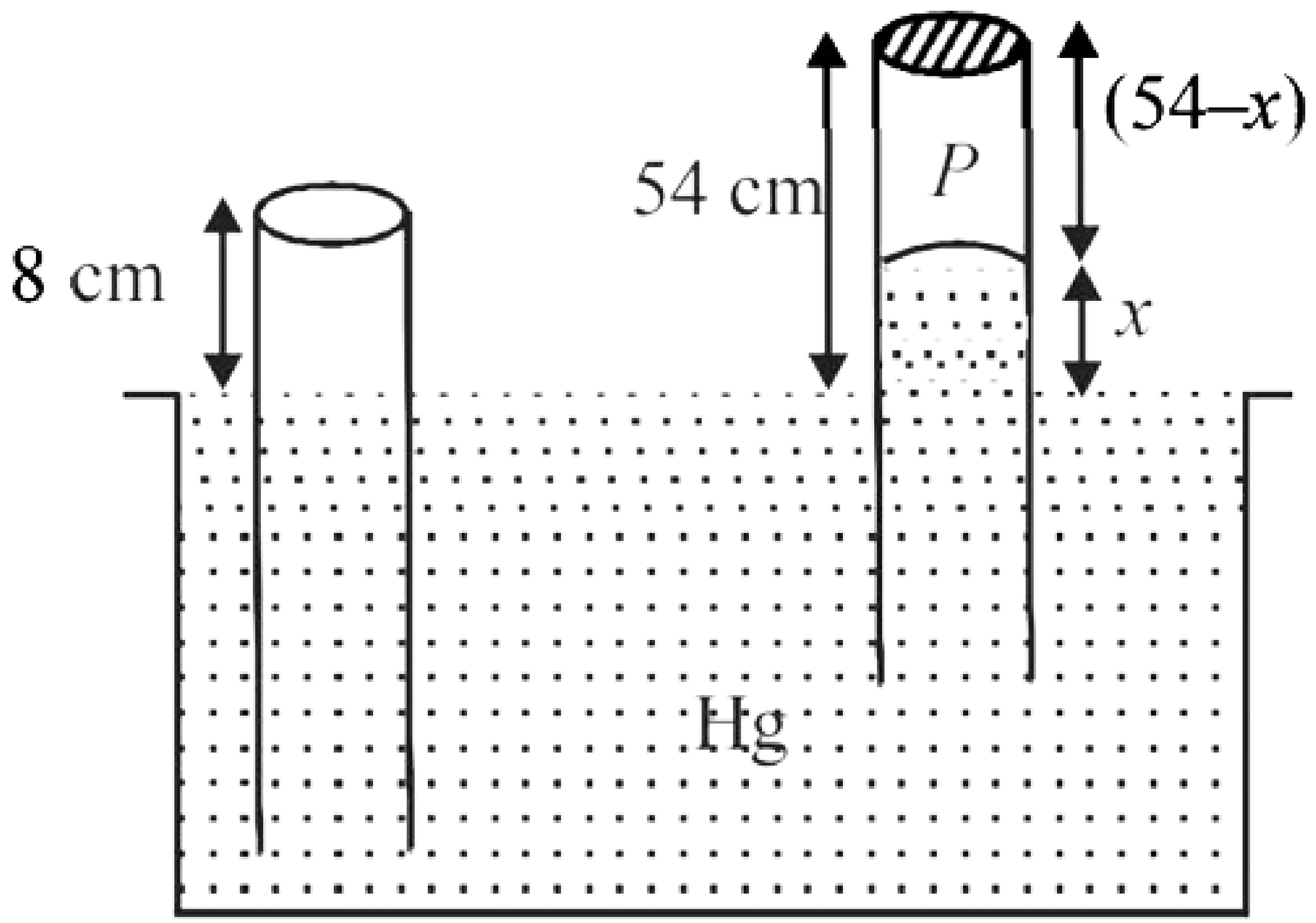
(B) (b) 22cm

(C) (c) 38cm

(D) (d) 6cm

CORRECT ANSWER: B

SOLUTION:



Length of the air column above mercury in the tube is,

$$P + x = P_0$$

$$\Rightarrow P = (76 - x)$$
$$\Rightarrow 8 \times A \times 76$$
$$= (76 - x) \times A$$
$$\times (54 - x)$$

$$\therefore x = 38$$

Thus, length of air column $= 54 - 38 = 16cm$.

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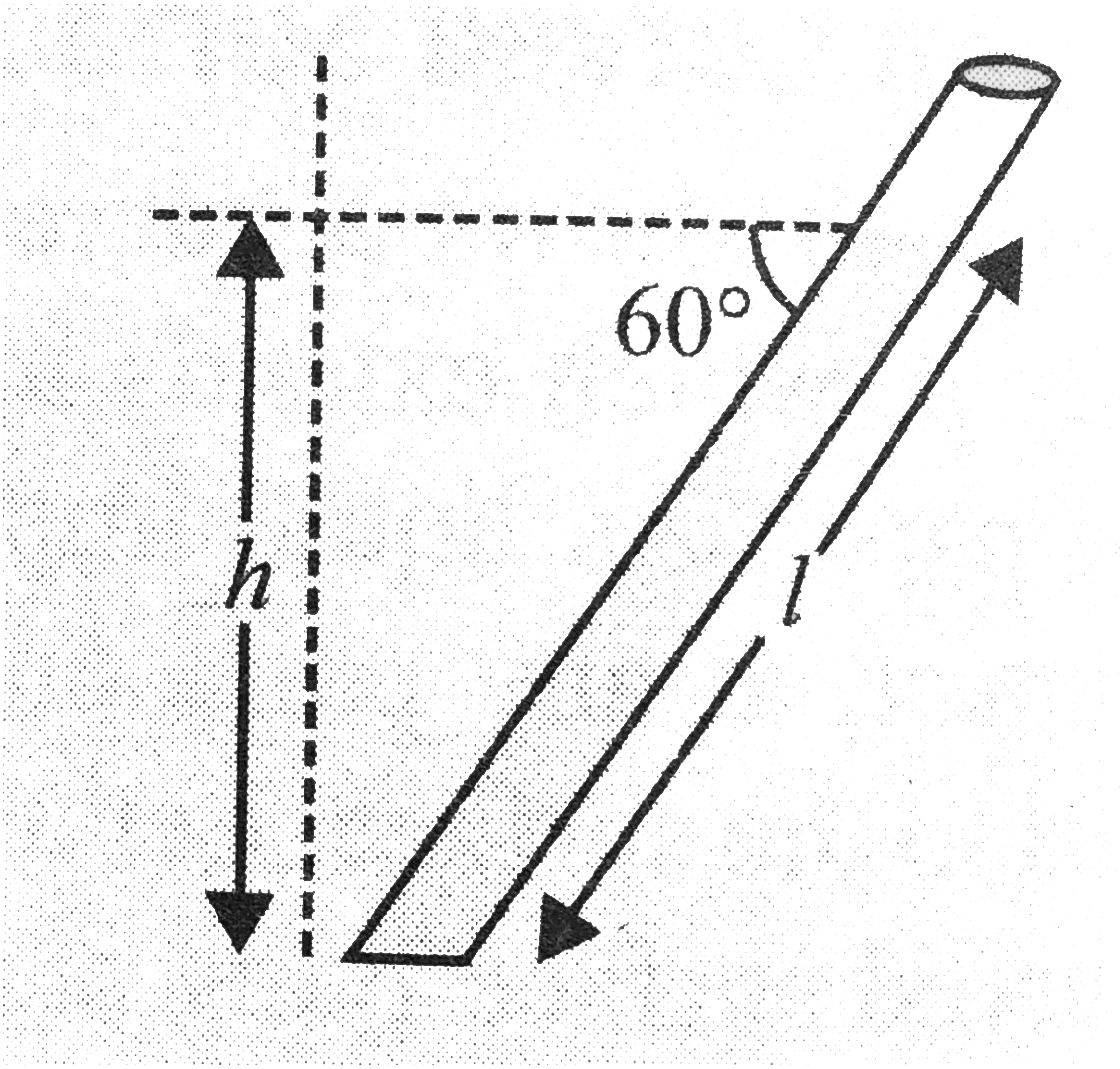
Q-59 - 11301920

What will be the length of mercury column in a barometer tube when the atmosperic pressure is $75cm$ of mercury and the tube is inclined at an angle of 60 with the horizontal direction?



SOLUTION:

The barametric height $h = 75cm$.

It l is the length of h mercury column in the tube, then if l is the length of the mercury column in the tube, then

$$\frac{h}{l} = \sin 60$$

or

$$l = \frac{h}{\sin 60^{\square}}$$

$$= \frac{75}{\left(\sqrt{3}/2\right)}$$

$$= 86.6cm$$

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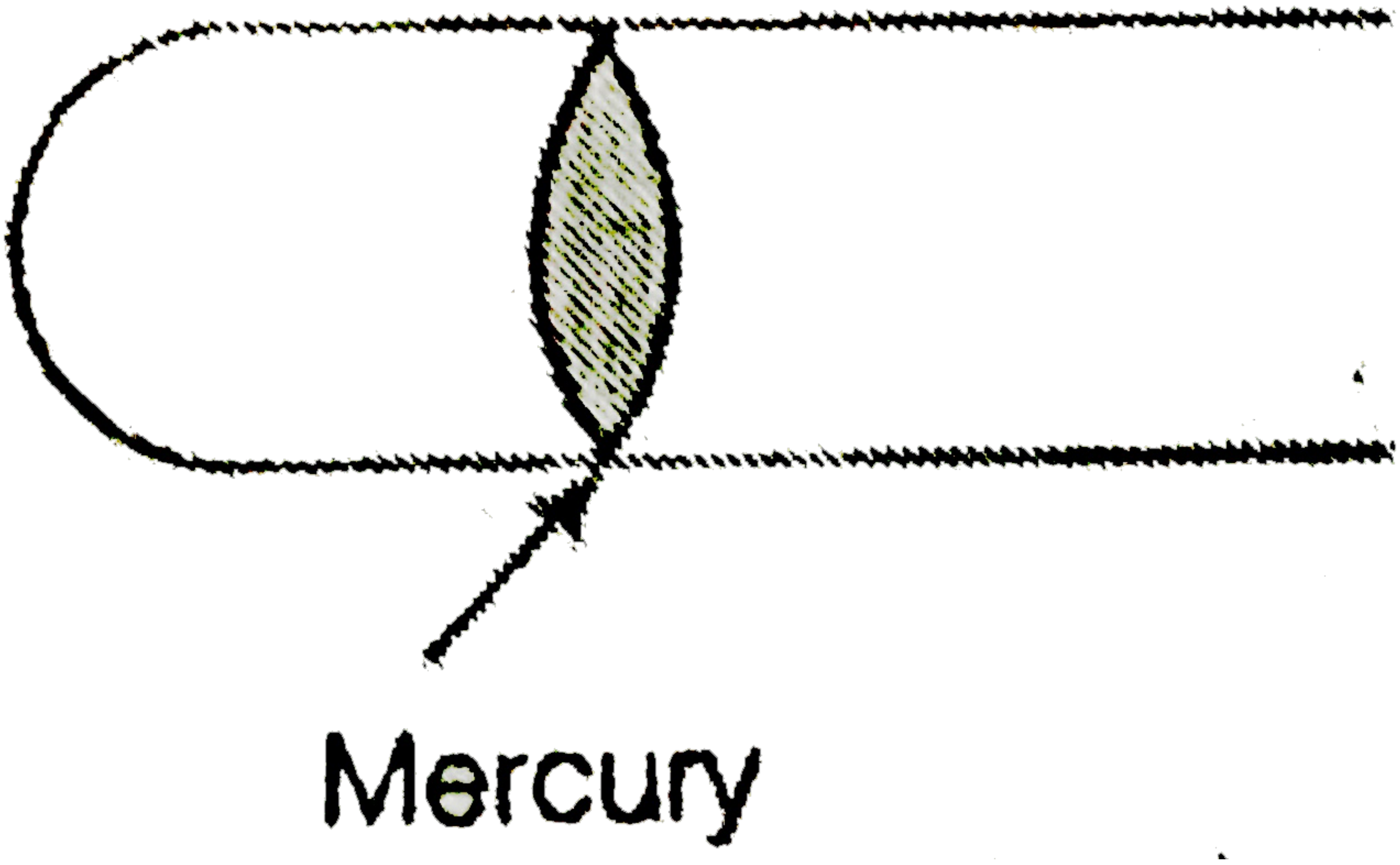
Q-60 - 19037315

A uniform tube is shown in figure, Which is open at one en and closed at the other . To enclose a column of air inside the tube, a pellet of mercury is introduced If the length of air column at $27C$ is

18 cm, at what temperature its length will be 21.6?`



(A) $87^\circ C$

(B) $91^\circ C$

(C) $85^\circ C$

(D) $97^\circ C$

CORRECT ANSWER: A

SOLUTION:

From Charless' law L $\propto$ T

$$\frac{L_1}{T_1} = \frac{L_2}{T_2}$$

$$\Rightarrow T_2 = \frac{L_2}{L_1} \times T_1$$

$$T_2 = \frac{216}{18} \times 300$$

$$T_2 = 87C$$