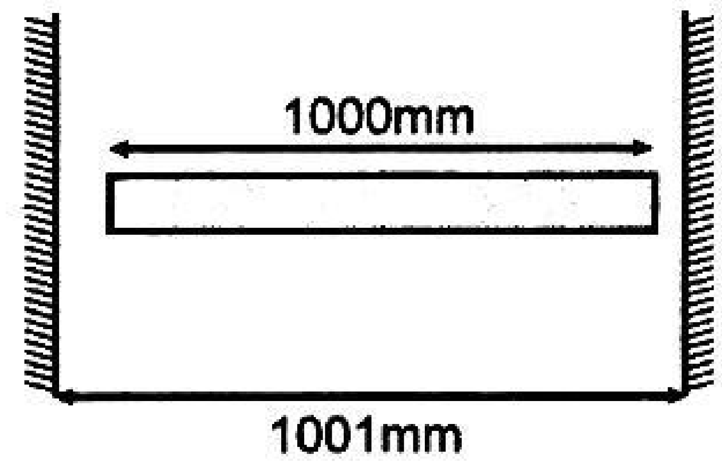
FLUID MECHANICS, HOME WORK SHEET-1

1. A rod of length 1000 mm and coefficient of linear expansion $\alpha = 10^{-4}$ per degree is placed symmetrically between fixed walls separated by 1001 mm. The Young's modulus of the rod is 10^{11} N/m^2. If the temperature is increased by 20 ºC, then the stress developed in the rod is (in N/m^2) :

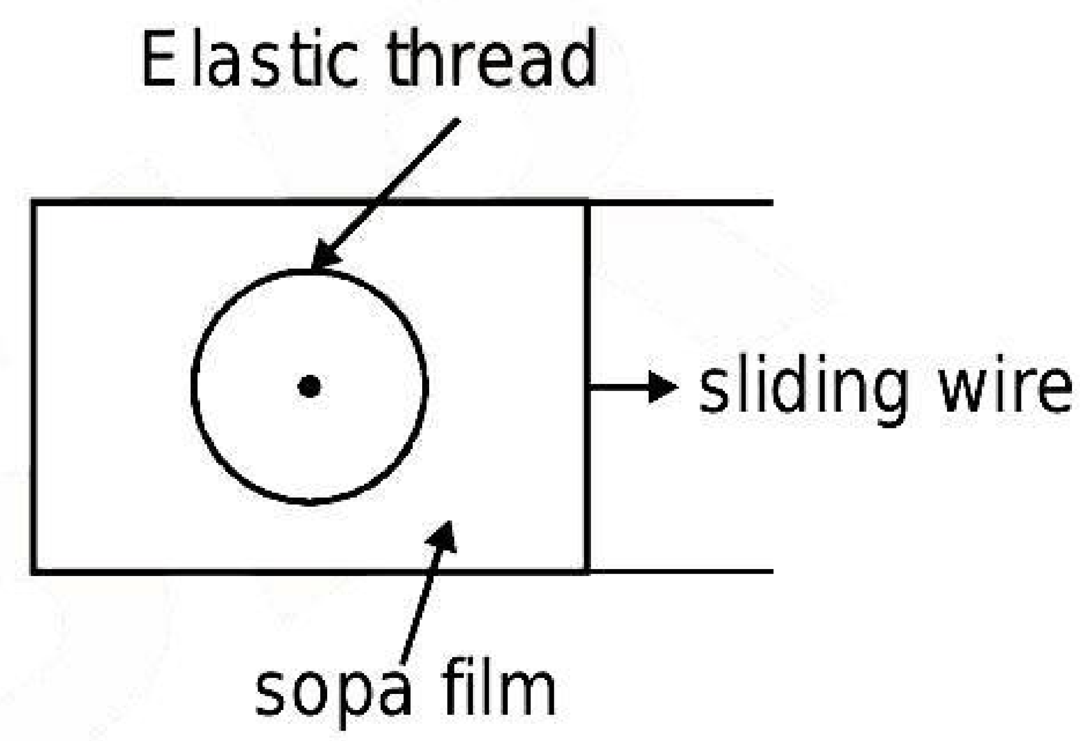


(A) 10 (B) 10^8
(C) 2×10^8 (D) cannot be calculated

2. A mosquito with 8 legs stagands on water surface an each leg makes depression of radius 'a'. If the surface tension and angle of contact are 'T' and zero respectively, then the weight of mosquito is :

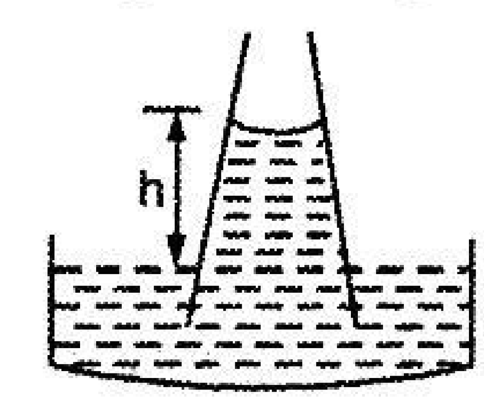
(A) 8 T . a (B) 16π T a (C) $\frac{Ta}{8}$ (D) $\frac{Ta}{16\pi}$

3. 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 of the circle formed by elastic thread will



(A) increase (B) decrease
(C) remains same (D) data insufficient

4. A capillary of the shape as shown is depped in a liquid. Contact angle between the liquid and the capillary is 0º and effect of liquid inside the meniscus is to be neglected. T is surface tension of the liquid, r is radius of the meniscus, g is acceleration due to gravity and ρ is den sity of the liquid then height h is equilibrium is



(A) greater than $\frac{2T}{r\rho g}$ (B) equal to $\frac{2T}{r\rho g}$

(C) less than $\frac{2T}{r\rho g}$ (D) of any value depending upon actual values

5. Shape of the menscus formed by two liquids when capillaries are dipped in them are shown. In I it is hemispherical where as in II it is flat. Pick correct statement regarding contact angles formed by the liquids in both situations

(A) It is 180º in I and 90º in II. (B) It is 0º in I and 90º in II
(C) It is 90º in I and 0º in II (D) It is greater than 90º in I and equal to 90º in II.

ANSWERS

HOME WORK SHEET-1

1. B 2. B 3. C 4. C 5. C

FLUID MECHANICS, HOME WORK SHEET-2

1. A glass tube scaled at both ends is 1m long. It lies horizontally with the middle 10 cm containing Hg. the two ends of the tube equal in length contain air at 27ºC and pressure 76 cm of Hg. The temperature at one ends is kept 0ºC and at the other end it is 127ºC. Neglect the change in length of Hg column. Then the change in length on two sides is

(A) 12.3 cm (B) 10.311 cm (C) 9.9 cm (D) 8.489 cm

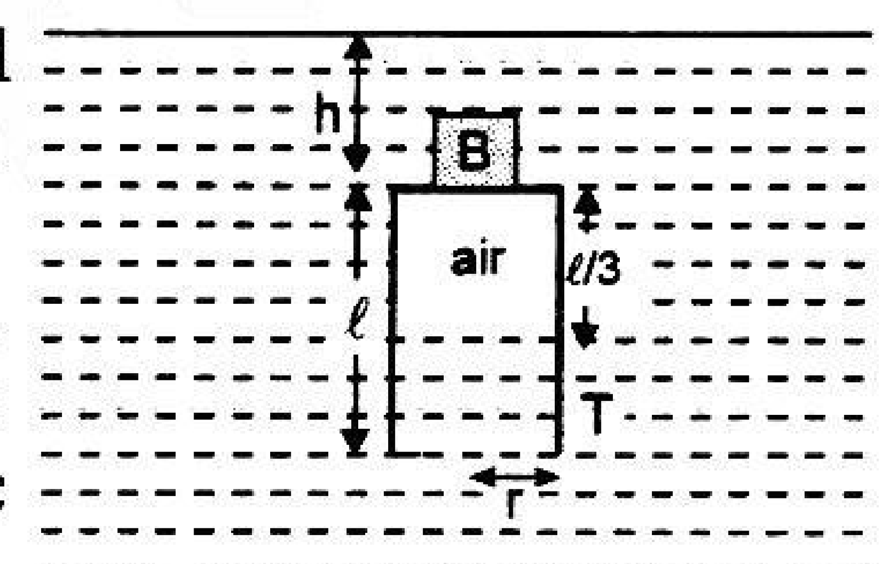
2. A thin tube of uniform cross-section is seated at both ends. If lies horizontally. The middle 5 cm containing Hg and two equal ends contain air at the same pressure P_0. When the tube is held at an angle of 60º with the vertical, the length of the air column above and below the Hg are 46 cm, 44.5 cm. Calculate pressure P_0 in cm of Hg. Assume temperature of the system constant.

(A) 55 cm of Hg (B) 65 cm of Hg (C) 70.4 cm of Hg (D) 75.4 cm of Hg

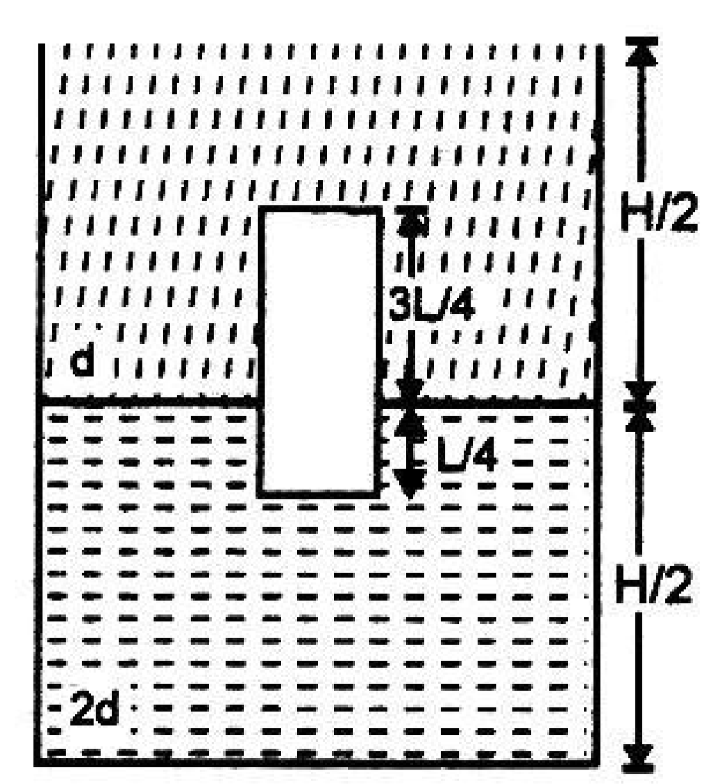
3. To construct a barometer, a tube of length 1 m is filled completely with mercury and is inverted in a mercury cup. The barometer reading on a particular day is 76 cm. Suppose a 1 m tube is filled with mercury up to 76 cm. It is inverted in a mercury cup. The height of mercury column in the tube over the surface in the cup will be

(A) zero (B) 76 cm (C) > 76 cm (D) < 76 cm

4. A light cylindrical tube 'T' of length ℓ and radius 'r' containing air is inverted in water (density d_1). One end of the tube is open and the other is closed. A block 'B' of density d_2 ($>d_1$) is kept on the tube as shown inthe figure. The tube stays in equilbrium in the position shown. Find the volume of 'B'. The density of the air is negligible as compared with the density of water. What is the pressure of the air i the tube assuming that the atmospheric pressure is P_0.



5. A container of a large uniform cross-sectional area A resting on a horizontal surface holds two immiscible, non-viscous and incompressible liquids of densities 'd' and '2d' each of height (1/2)H as shown. The smaller density liquid is open to atmosphere. A homogeneous solid cylinder of length $L\left(<\frac{1}{2}H\right)$ cross-sectional area (1/5)A is immersed such that it floats with its axis vertical to the liquid-liquid interface with length (1/4) L in denser liquid. If D is the density of the solid cylinder then :



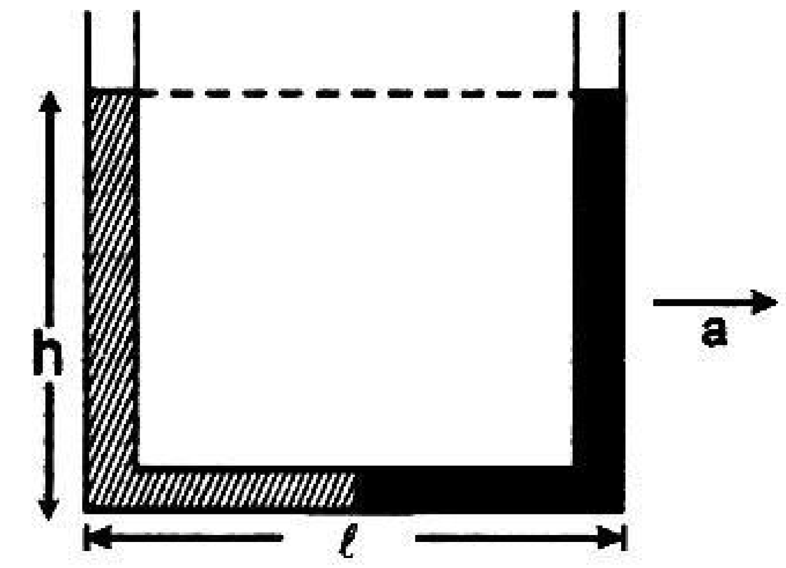
(A) $D=\frac{3d}{2}$ (B) $D=\frac{d}{2}$

(C) $D=\frac{2d}{3}$ (D) $D=\frac{5d}{4}$

6. A cylindrical wooden float whose base area S and the height H drifts on the water surface. Density of wood d and density of water is ρ. What minimum work must be performed to take the float out of the water?

7. A cube (density 0.5 gm/cc) of side 10 cm is floating in water kept in a cylinderical beaker of base area 1500 cm^2. When a mass m is kept on wooden block the level of water rises in the beaker by 2mm. Find the mass m.

8. A U-tube of base length "ℓ" filled with same volume of two liquids of densities ρ and 2ρ is moving with an acceleration "a' on the horizontal plane. If the height difference between the two surfaces (open to atmosphere) becomes zero, then the height h is given by :



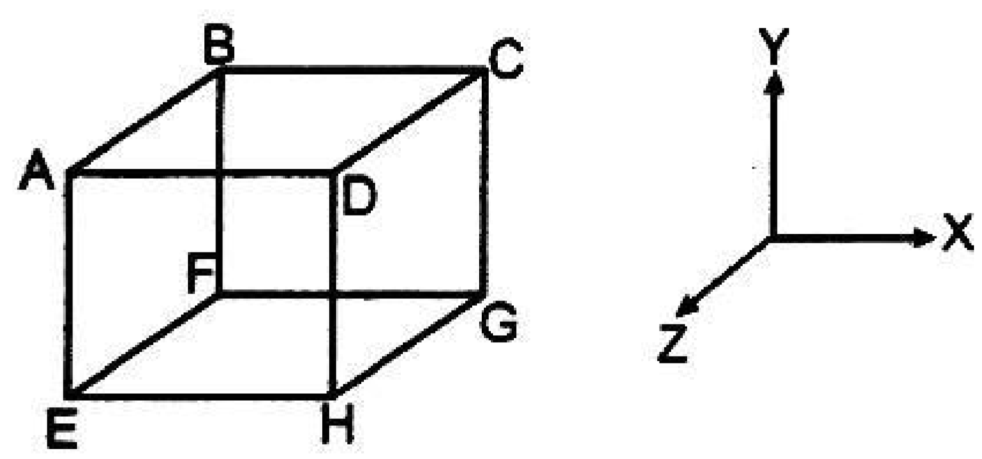
(A) $\frac{a}{2g}\ell$ (B) $\frac{3a}{2g}\ell$

(C) $\frac{a}{g}\ell$ (D) $\frac{2a}{3g}\ell$

9. The cubical container ABCDEFGH which is completely filled with an ideal (nonviscous and incompressible) fluid, moves in a gravity free space with a acceleration of

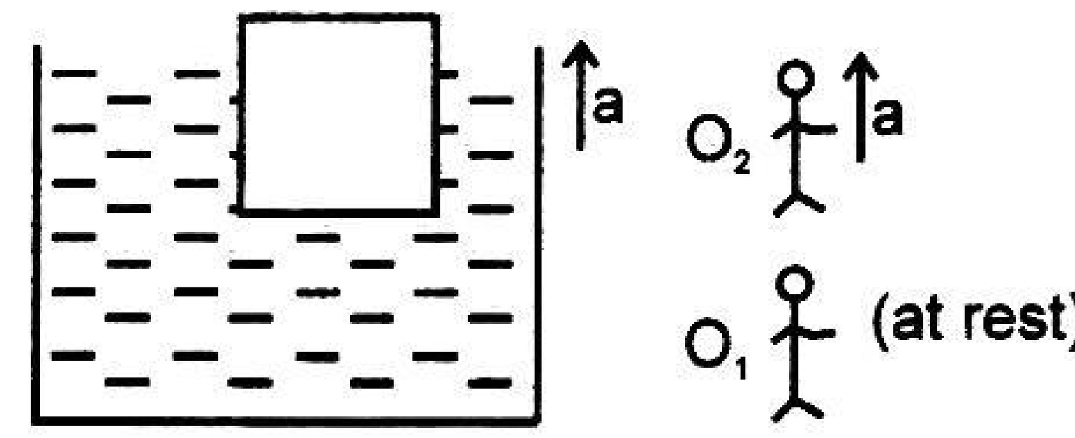
$$\vec{a} = a_0(\hat{i} - \hat{j} + \hat{k})$$

where a_0 is a positive constant. Then the only point in the container where pressure can be zero is



(A) H (B) C (C) E (D) F

10. A block is partially immersed in a liquid and the vessel is accelerating upwards with an acceleration "a". The block is observed by two observers O_1 and O_2, one at rest and the other accelerating with an acceleration "a" upward. The total buoyant force on the block is :



(A) same for O_1 and O_2 (B) greater for O_1 than O_2
(C) greater for O_2 than O_1 (D) data is not sufficient

ANSWERS

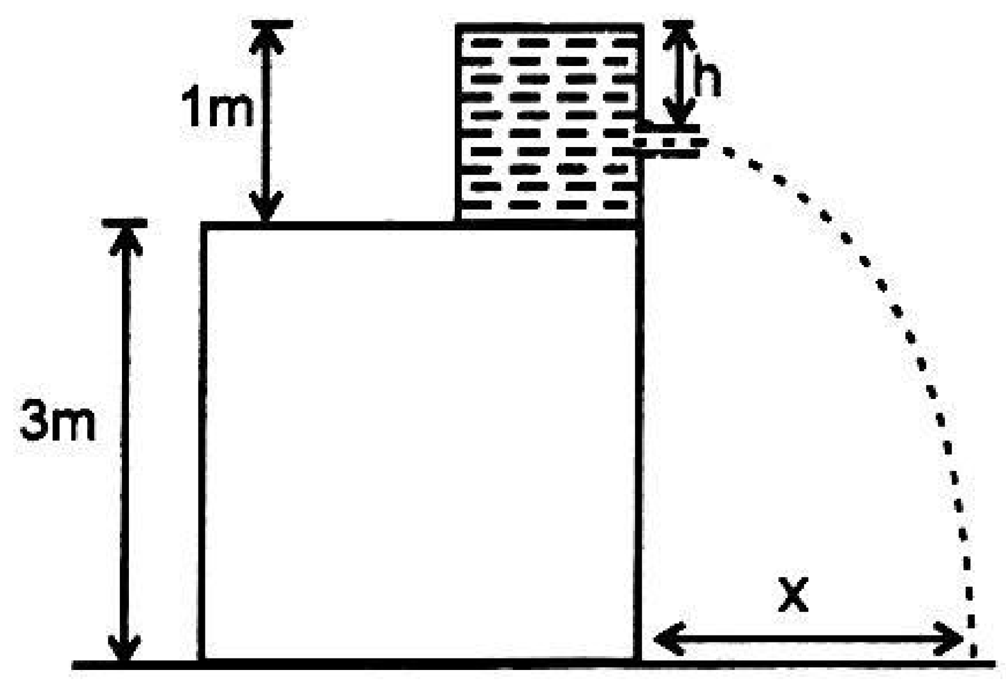
HOME WORK SHEET-2

1. D 2. D 3. D 4. $P_a = P_0 + d_1 g\left(h + \frac{\ell}{3}\right)$ 5. D

6. $\frac{Sgd^2H^2}{2\rho}$ 7. $m = 300$ gm. 8. B 9. A 10. A

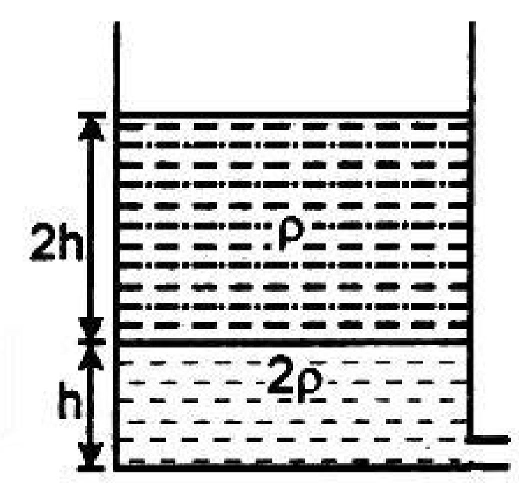
FLUID MECHANICS, HOME WORK SHEET-3

1. A water tank stands on the roof of a building as shown. Then the value of h for which the distance covered by the water 'x' is greatest is



(A) 0.5 m (B) 0.67 m (C) 1 m (D) none of these

2. The velocity of the liquid coming out of a small hole of a large vessel containing two different liquids of densities 2ρ and ρ as shown in figure is



(A) $\sqrt{6gh}$ (B) $2\sqrt{gh}$ (C) $2\sqrt{2gh}$ (D) $\sqrt{gh}$

3. A large open tank has two small holes in its vertical wall as shown in figure. ONe is a square hole of side 'L' at a depth '4y' from the top and the other is a circular hole of radius 'R' at a depth 'y' 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 :

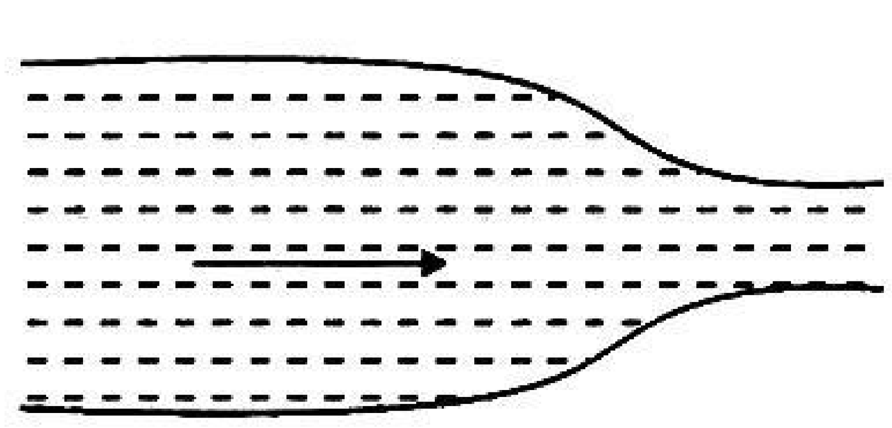
(A) $\frac{L}{\sqrt{2\pi}}$ (B) $2\pi L$ (C) $\sqrt{\frac{2}{\pi}} \cdot L$ (D) $\frac{L}{2\pi}$

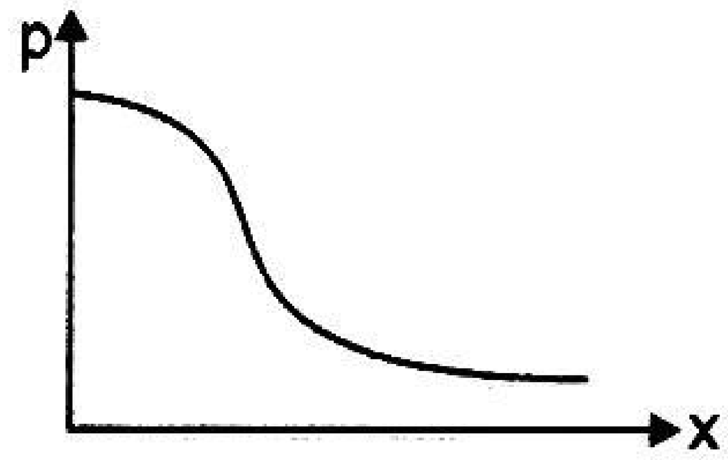
4. Fountains usually sen in gardens are generated by a wide pipe with an enclosure at one end having many small holes. Consider one such fountain which is produced by a pipe of internal diameter 2 cm in which water flows at a rate $3ms^{-1}$. The enclosure has 100 holes each of diameter 0.05 cm. The velocity of water coming out of the holes is (in ms^{-1})

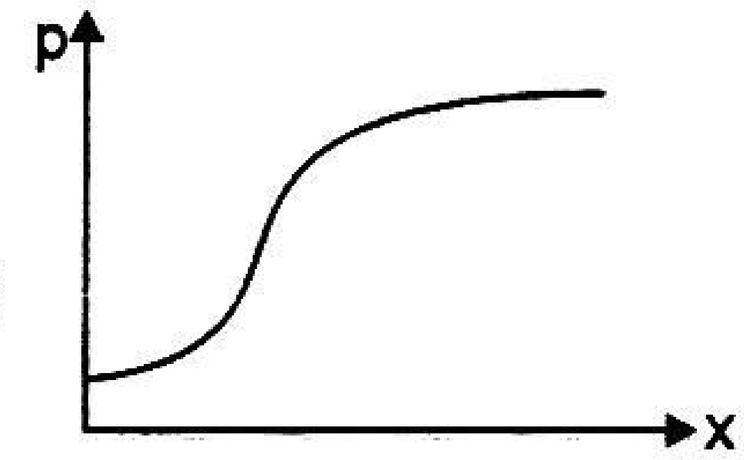
(A) 0.48 (B) 96 (C) 24 (D) 48

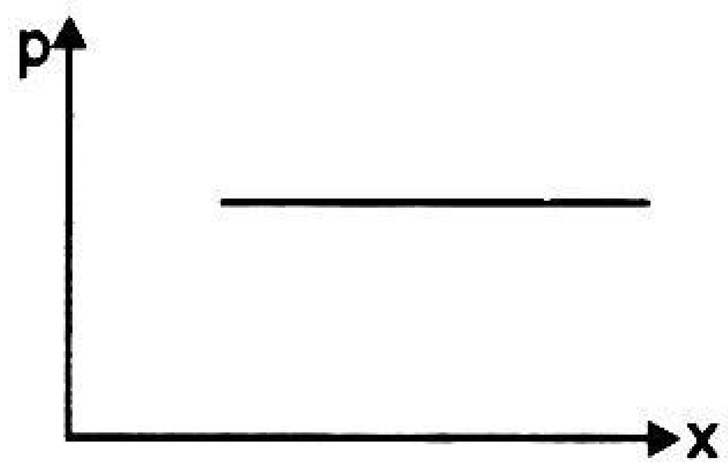
5. A fixed container of height 'H' with large cross-sectional area 'A' is completely filled with water. Two small orifice of cross-sectional area 'a' are made, one at the bottom and the other on the vertical side of the container at a distance H/2 from the top of the container. Find the time taken by the water level to reach a height of H/2 from the bottom of the container.

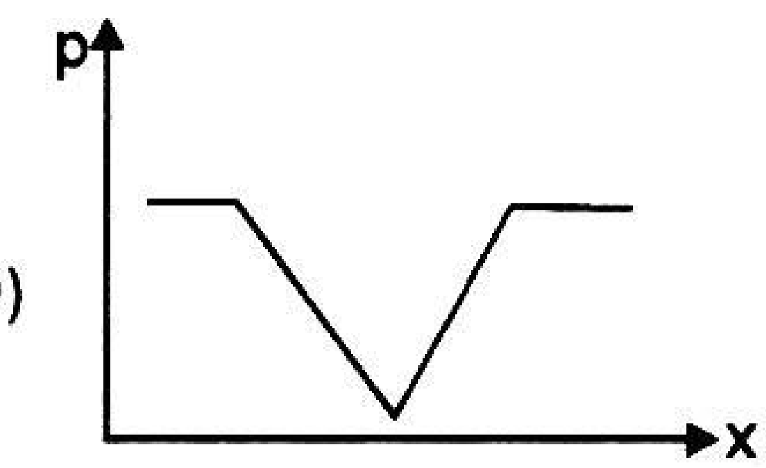
6. Water flows through a frictionless duct with a cross-section varying as shown in figure. Pressure p at points along the axis is represented by :



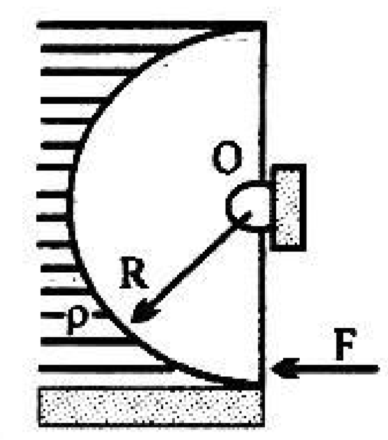
(A) 

(B) 

(C) 

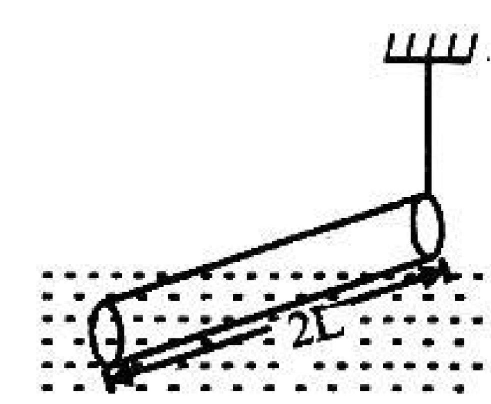
(D) 

7. A light semi cylindrical gate of radius R is piovted at its mid point O, of the diameter as shown in the figure holding liquid of density ρ. The force F required to prevent the rotation of the gate is equal to



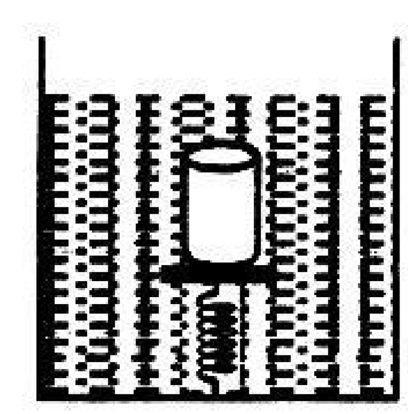
(A) $2\pi R^3\rho g$ (B) $2\rho g R^3 l$ (C) $\frac{2R^2 l\rho g}{3}$ (D) none of these

8. A slender homogeneous rod of length 2L floats partly immersed in water, being supported by a string fastened to one of its ends, as shown. The specific gravity of the rod is 0.75. The length of rod that extends out of water is :



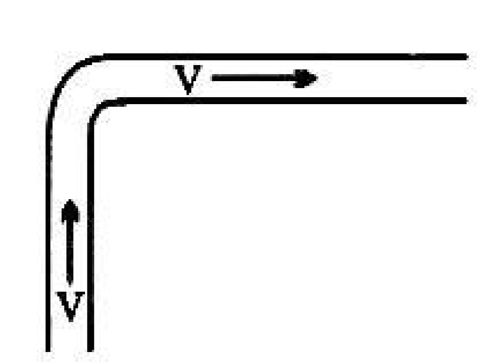
(A) L (B) $\frac{1}{2}L$ (C) $\frac{1}{4}L$ (D) 3 L

9. A cylindrical block of area of cross-section A and of material of density ρ is placed in a liquid of density one-third of density of block. The block compresses a spring and compression in the spring is one-third of the length of the block. If acceleration due to gravity is g, the spring constant of the spring is :



(A) ρAg (B) $2\rho Ag$ (C) $2\rho Ag/3$ (D) $2Ag/3$

10. A fire hydrant delivers water of density ρ at a volume rate L. The water travels vertically upward through the hydrant and then does 90º turn to emerge horizontally at speed V. The pipe and nozzle have uniform crossection throughout. The force exerted by the water on the corner of the hydrant is



(A) ρVL (B) zero (C) $2\rho VL$ (D) $\sqrt{2}\rho VL$

ANSWERS

HOME WORK SHEET-3

1. C 2. B 3. C 4. D 5. $t=\frac{2A}{3a}\left(\sqrt{2}-1\right)\sqrt{\frac{H}{g}}$

6. A 7. D 8. A 9. B 10. D