PHYSICS

BOOKS - CP SINGH PHYSICS (HINGLISH)

FLUID MECHANICS

Example

1. When equal volumes of two substance are mixed, the specific gravity of the mixurie is 4.

When equal weights of the same substance are mixed, the specific gravity of the mixture is 3. The soecufuc gravities of the two substance could be

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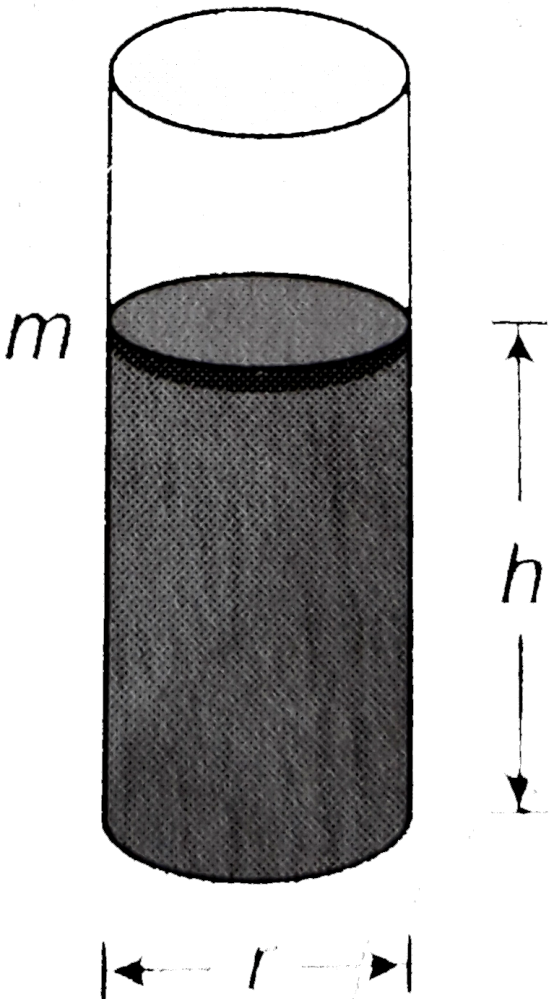
2. A cylinder vessel containing a liquid of density ρ is closed by a smooth piston of mass m as shown. If atmospheric pressure is P_0, radius of cylinder is r and height of liquid is h. Find

(a) Pressure of liquid just below the piston

(b) force at bottom of cylinder.



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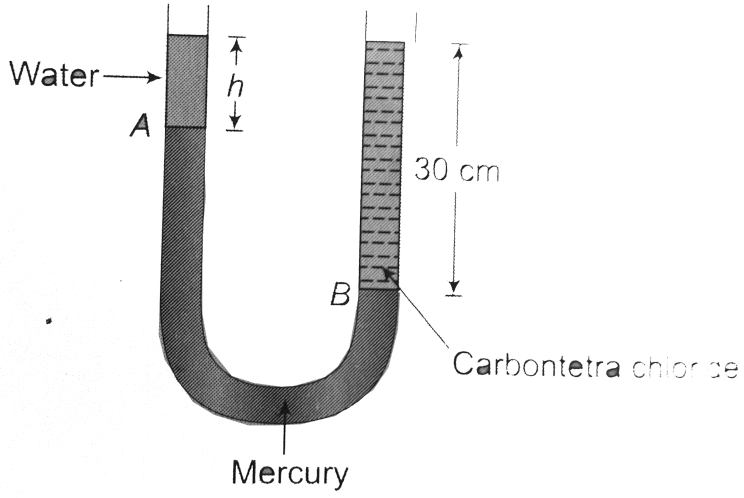
3. Consider the situation shown in diagram.

Determine h

$\rho_\omega = 1g/cc.\ \rho_m = 13.6g/cc$

$\rho_c = 1.6g/cc.$



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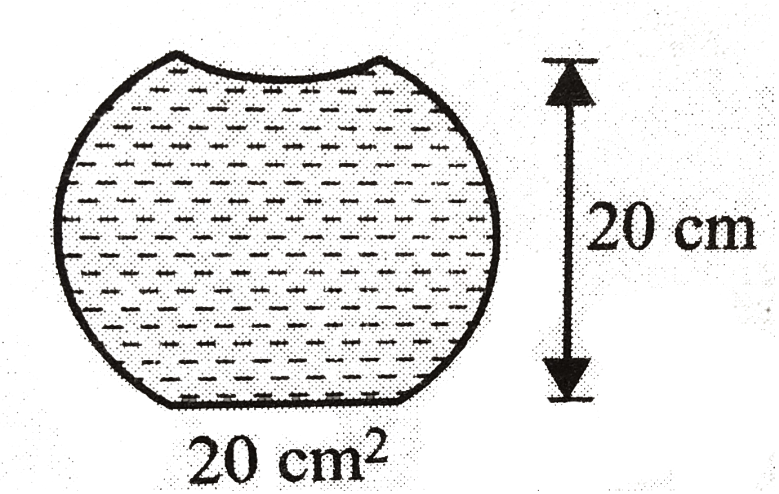
4. A glass full of water has a bottom of area $20cm^2$, top of area $20cm$, height $20cm$ and volume half a litre.



a. Find the force exerted by the water on the bottom.

b. Considering the equilibrium of the v, after. find the resultant force exerted by the side, of

the glass on the water. Atmospheric pressure $= 1.0 \times 10^5 N/m^2$. Density of water $= 1000 kg/m^{-3}$ and $g = 10 m/s^2$

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5. Suppose the glass of the previous problem is covered by a jar and the air inside the jar is completely pumped out.

(a) What will be the answer to the problem ?

(b) Show that the answers do not change if a glass of different shape is used provided the

height, the bottom area and the volume are unchanged.

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6. What is filled in a rectangular tank of size $3m \times 2m \times 1m$.

(a) Find the total force exerted by the water on the bottom surface of the tank.

(b) Consider a vertical side of area $2m \times 1m$. Take a horizontal strip of width δx metre in this side, situated at a depth of x metre from

the surface of water. Find the force by the water on this strip.

(c) Find the torque of the force calculated in part (b) about the bottom edge of this side.

(d) Find the total force by the water on this side.

(e) Find the total torque by the water on the side about the bottom, edge. Neglect the atmospheric pressure and take $g = 10m / s^2$.

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7. A bucket of water is suspended from a spring balance. What happens to reading of balance

(a) when a piece of stone suspended from a string is immersed in the water without touching the bucket

(b) when a piece of lead or cork is put in the water in the bucket.

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8. A beaker containing water is placed on the pan of a spring balance which shows a reading of W_0. A lump of sugar of mass m and volume v is now suspended by a thread (from an independent support). How will the reading change as time passes on ?

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9. A boat floating in a water tank is carrying a number of large stones. If the stones are

unloaded into water, what will happen to the water level?

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10. A solid of density σ floats in a liquid of density ρ. What will happen to level of liquid if solid melts ?

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11. A piece of ice floating in a vessel filled with water. As the ice piece melts, what happens to the water level if

(a) (i) ice melts and (ii) ice piece contains an air bubble

(b) ice piece contains (i) a lead piece and (ii) a cork piece.

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12. (a) An ornament weighting $36g$ in air, weights only $34g$ in water. Assuming that some copper is mixed with gold to prepare the ornament, find the amount of copper in it. Specific gravity of gold is 19.3 and that of copper is 8.9.

(b) Refer to the previous problem. Suppose, the goldsmith argues that he has not mixed copper or any other material with gold, rather some cavities might have been left inside the ornament. Calculate the volume of the cavities

left that will allow the weights given in that problem.

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13. An ice cube floats in water. What percentage of volume is outside water. Density of water $= 1g/cc$, density of ice $= 0.9g/cc$.

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14. A solid ball of density half that of water falls freely under gravity from a height of $20m$ and then enters water. Up to what depth will the ball go ? How much time will it take to come again to the wate surface ? Neglect air resistance and viscosity effect in water.

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15. A cubical block of wood weighing $200g$ has a lead piece fastened underneath. Find the

mass of the lead pieces which will just allow the block to float in water. Specific gravity of wood is 0.8 and that of lead is 11.3.

(b) Solve the previous problem if the lead piece is fastened on the top surface of the block and the block is to float with its upper surface just dipping into water.

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16. A cubical metal block of edge 12 cm floats in mercry with one fifth of the height inside the

mercury. Water poured till the surface of the block is just immersed in it. Find the height of the block is just immersed in it. Find the height of the water column to be poured. Specific gravity of mercury =13.6.

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17. A cube ofice of edge 4 cm is placed in an empty cylindrical glass of inner diameter 6 cm. Assume that the ice melts uniformly from each side so that it always retains its cubical shape.

Remembering that ice lighter than water, finding the length of the edge of the ice cube at the instant it just leaves contact with the bottom of the glass.

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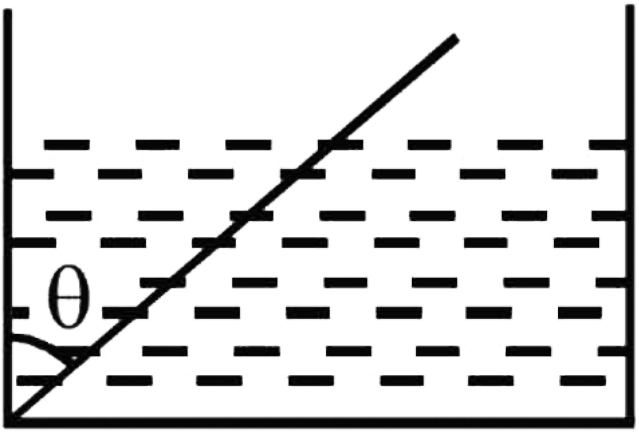
18. A wooden plank of length 1m and uniform cross-section is hinged at one end to the bottom of a tank as shown in fig. The tank is filled with water upto a hight 0.5m. The specific gravity of the plank is 0.5. Find the

angle θ that the plank makes with the vertical in the equilibrium position. (Exclude the case $\theta = \theta^\circ$)



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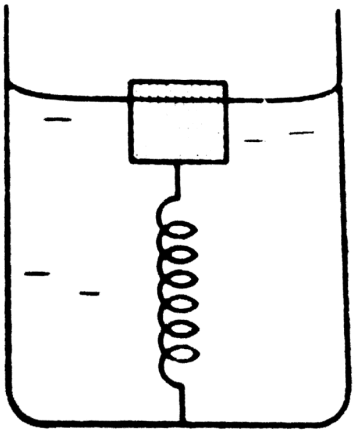
19. A cubical block of wood of edge 3 cm floats in water. The lower surface of the cube just

touches the free end of a vertical spring fixed at the bottom of the pot. Find the maximum weight that can be put on the block without wetting it. Density of wood $=800 kgm^{-3}$ and spring constant of the spring $= 50 Nm^{-1} Takeg = 10 ms^{-2}$.



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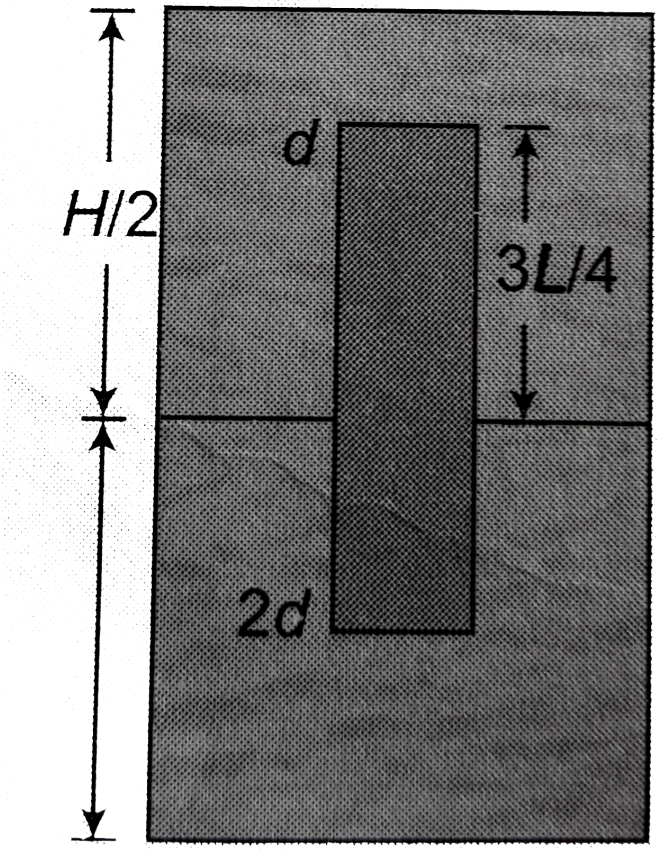
20. A container of a large uniform cross-sectional area A resting on a horizontal surface holds two immiscible, non viscous and incompressible liquids of densities d and $2d$, each of height $H/2$ as shown in figure. The lower density liquid is open to atmosphere. A homogeneous solid cylinder of length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

(a) density D of the solid and

(b) the total pressure at the bottom of the container. (Atmospheric pressure $= P_0$).



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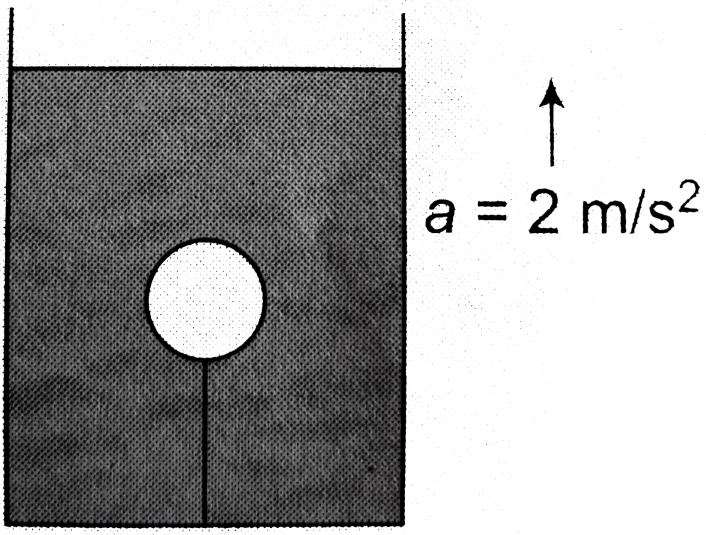
21. A solid sphere of mass $m = 2kg$ and specific gravity $s = 0.5$ is held stationary relative to a tank filled with water. The tank is accelerating upward with acceleration $2m/s^2$. Calculate

(a) Tension in the thread connected between the sphere and the bottom of the tank.

(b) If the thread snaps, calculate the acceleration of sphere with respect to the tank.

(Density of water

$= 1000 kgm^{-3}, g = 10 ms^{-2}$).



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22. A wooden stick of length L, radius R and density ρ has a small metal piece of mass m (of negligible volume) attached to its one end.

Find the minimum value for the mass m (in terms of given parameters) that would make the stick float vertically in equilibrium in a liquid of density $\sigma(>\rho)$.

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23. A solid sphere of radius R is floating in a liquid of density σ with half of its volume submerged. If the sphere is slightly pushed and released , it starts axecuting simple

harmonic motion. Find the frequency of these oscillations.

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24. A uniform cylinder of length (L) and mass (M) having cross sectional area (A) is suspended, with its length vertical, from a fixed point by a massless spring, such that it is half - submerged in a liquid of density (rho) at equilibrium position. When the cylinder is given a small downward push and released it

starts oscillating vertically with small amplitude. If the force constant of the spring is (k), the prequency of oscillation of the cylindcer is.

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25. A liquid of density $800kg/m^3$ flowing steadily in a tube of varying cross-section. If area of cross-section at A is $4cm^2$ and at B is $2cm^2$. If speed of liquid at A is $10cm/s$, calculate

(i) the rate of flow

(ii) the difference in pressures at A and B.

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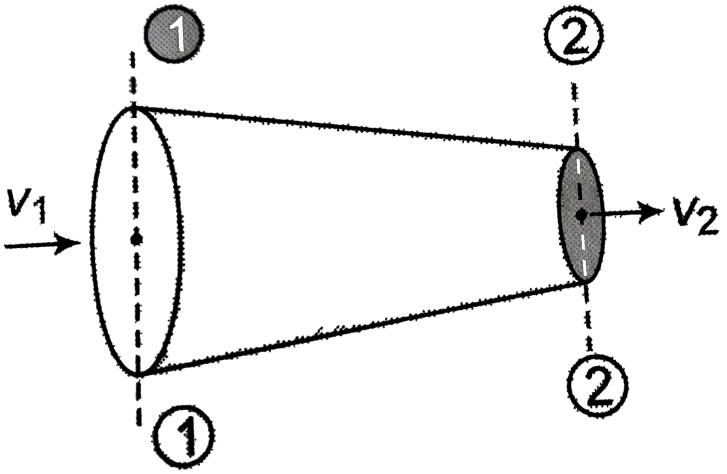
26. Water is flowing steadily through a horizontal pipe of non-uniform cross-section. If the pressure of water is $4 \times 10^4 N/m^2$ at a point where cross-section is $0.02m^2$ and velocity of flow is $2m/s$. What is the pressure at a point where cross-section reduces to

$0.01m^2$?



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27. Air is streaming past a horizontal air plane wing such that its speed is $120ms^{-1}$ over the upper surface and $90ms^{-1}$ at the lower surface. If the density of air is $1.3kgm^{-3}$m find

the difference in pressure between the top and bottom of the wing. If the wing is $10m$ long and has an average width of $2m$, calculate the gross lift of the wing.

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28. Water is flowing continuously from a tap having an internal diameter 8×10^{-3}m. The water velocity as it leves the tap is $0.4ms^{-1}$. The diameter of the water stream at a

distance 2×10^{-1}m below the tap is close to $(g = 10m/s^2)$

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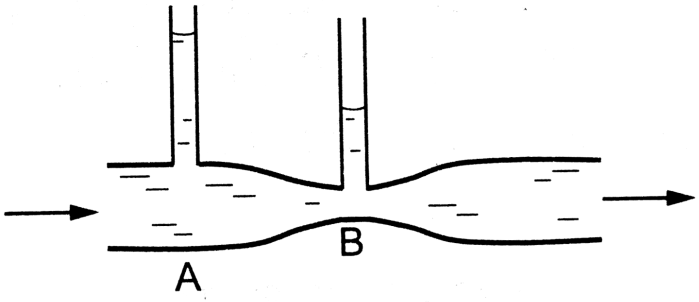
29. Water flows through a horizontal tube as shown in figure. If the difference of heights of water colun in the vertical tubes is 2 cm and the area of cross section at A and B are $4cm^2$ and $2cm^2$ respectively, find the rate of

flow of water across any section.



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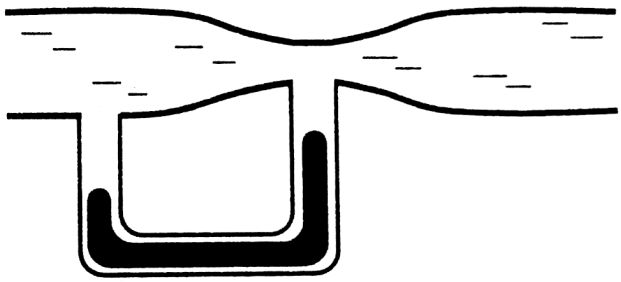
30. Water flows through the tube shown in figure. The areas of cross section of the wide and the narrow portions of the tube are $5cm^2$ and $2cm^2$ respectively. The rate of flow of water through the tube is $500cm^3s^{-1}$. Find

the difference of mercury levels in the U-tube.



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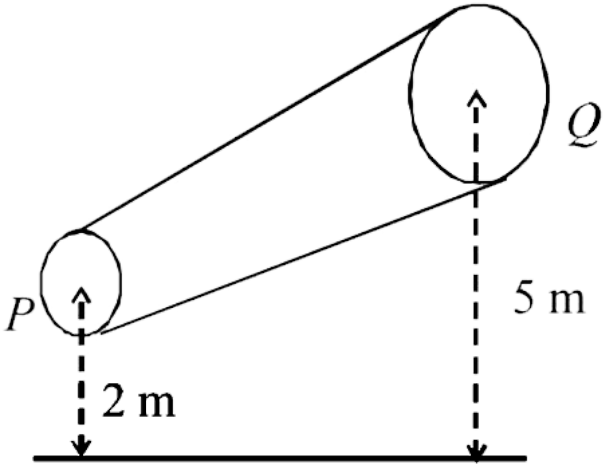
31. A non-viscous liquid of constant density $1000kg/m^3$ flows in a streamline motion along a tube of variable cross section. The tube is kept inclined in the vertical plane as shown in Figure. The area of cross section of

the tube two point P and Q at heights of 2 metres and 5 metres are respectively $4 \times 10^{-3} m^2$ and $8 \times 10^{-3} m^2$. The velocity of the liquid at point P is $1 m/s$. Find the work done per unit volume by the pressure and the gravity forces as the fluid flows from point P to Q.



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32. Water stands at a depth H in a tank whose side walls are vertical. A hole is made on one of the walls at a depth h below the water surface. Find at what distance from the foot of the wall does the emerging stream of water strike the floor and for what value of h this range is maximum ? What is the maximum possible range ?

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33. A cylindrical tank $1m$ in radius rests on a platform $5m$ high. Initially the tank is filled with water to a height of $5m$. A plug whose area is $10^{-4}m^2$, is removed from an orifice on the side of the tank at the bottom. Calculate the following :

(a) Initial speed with which the water flows from the orifice.

(b) Initial speed with which the water strikes the ground,

(c) Time taken to empty the tank to half its original value.

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34. The density of liquid contained in the tank of area $0.5m^2$ is $1200kg/m^2$. It has a hole of area $1cm^2$ near the bottom. A load of $30g$ is applied on the liquid at the top. Find the velocity of efflux when the height of liquid level is $75cm$ above the bottom. Take $g = 10m/s^2$.

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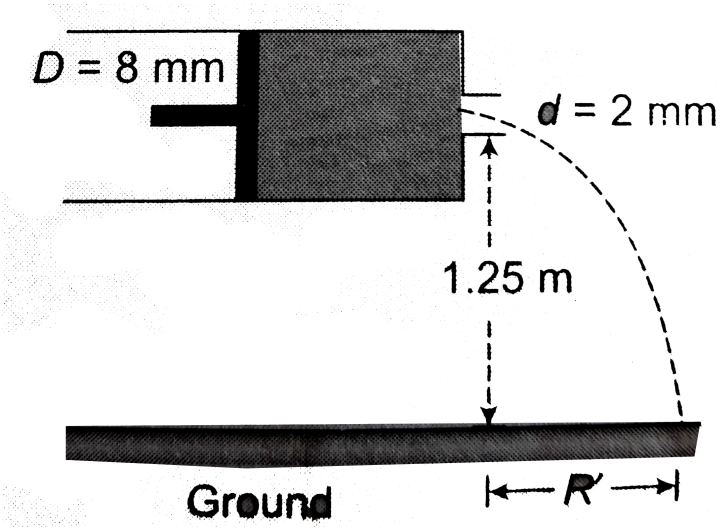
35. Consider a horizontally oriented syringe containing water located of a height of $1.25m$ above the ground. The diameter of plunger is $8mm$ and the diameter if the nozzle is $2mm$. The plunger is pushed with a constant speed of $0.25m/s$. Find the horizontal range of water stream on the ground. Take $g = 10m/s^2$.



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36. A cylindrical tank has a small hole at bottom. At $t = 0$, a tap starts to supply water into the tank at a constant rate $\beta m^3 / s$.

(a) Find the maximum level of water $H_{\max}$ in the tank ?

(b) At what time level of water becomes $h(h < H_{\max})$ Given a , area of hole, A : area of tank.

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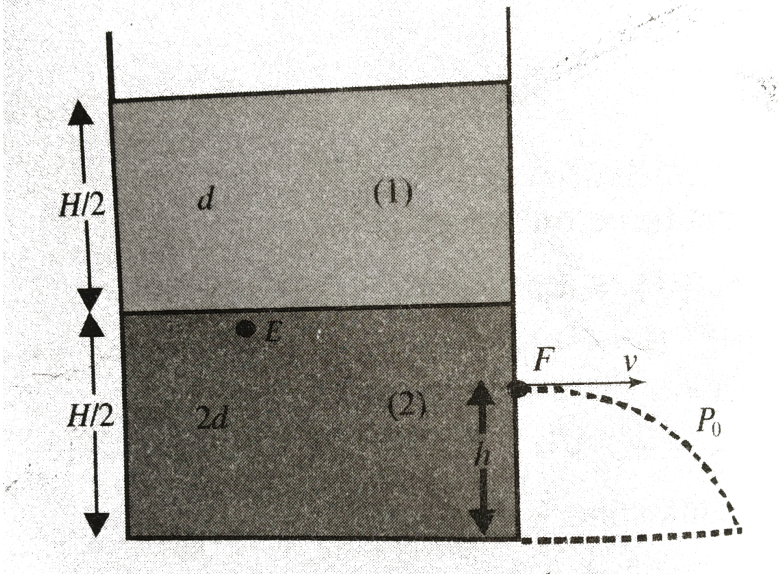
37. A container of large uniform cross sectional area A, resting on horizontal surface, holds two immiscible non viscous and incompressible liquids of density d and $2d$, each of height $\frac{H}{2}$ as shown in the figure. The lower density liquid is open to the atmosphere having pressure P_0. A tiny hole of area $(s(s << A)$ is punched on the vertical side of the container at a height $h\left(h < \frac{H}{2}\right)$. Determine



a.the initial speed of efflux of the liquid at the hole

b. the horizontal disance x travelled by the liquid initially

c. the height h_m at which at the hole should be punched so that the liquid travels the maximum distance x_m initially. also calculate x_m (neglect air resistance in calculations).

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38. On the opposite sides of a wide vertical vessel filled with water, two identical holes are opened, each having cross section area a. The height difference between them is equal to h. Find the resultant force of reaction of water flowing out of vessel.

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39. A cylindrical vessel filled with water upto a height of $2m$ stands on horizontal plane. The side wall of the vessel has a pugged circular hole touching the bottom. If the minimum diameter of the hole so that the vessel begins to move on the floor if the plug is removed is $\frac{x}{10\sqrt{\pi}}$ meter then x will be (if the coefficient of frication between the bottom of the vessel and the plane is 0.4 and total mass of water plus vessel is $100kg$.)

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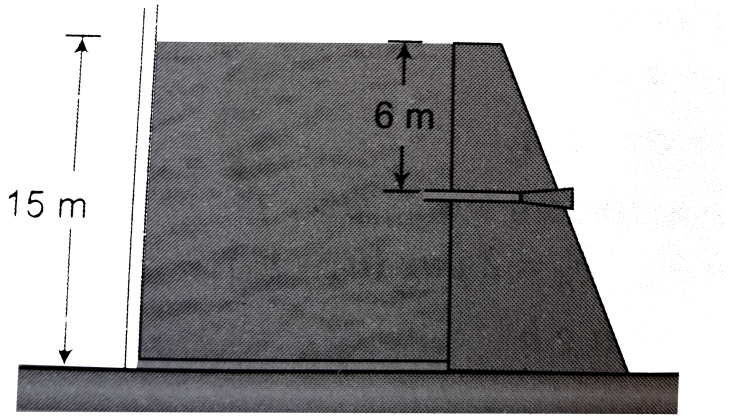
40. The fresh water behind a reservoir dam is $15m$ deep. A horizontal pipe $4.0cm$ in diameter passes through the dam $6.0m$ below the water surface as shown in the figure. A plug secures the pipe opening :

(a) Find the friction force between the plug and the pipe wall.

(b) The plug is removed. What volume of water flows out of the pipe in 3.0 hour ? Assume that

reservoir is large.



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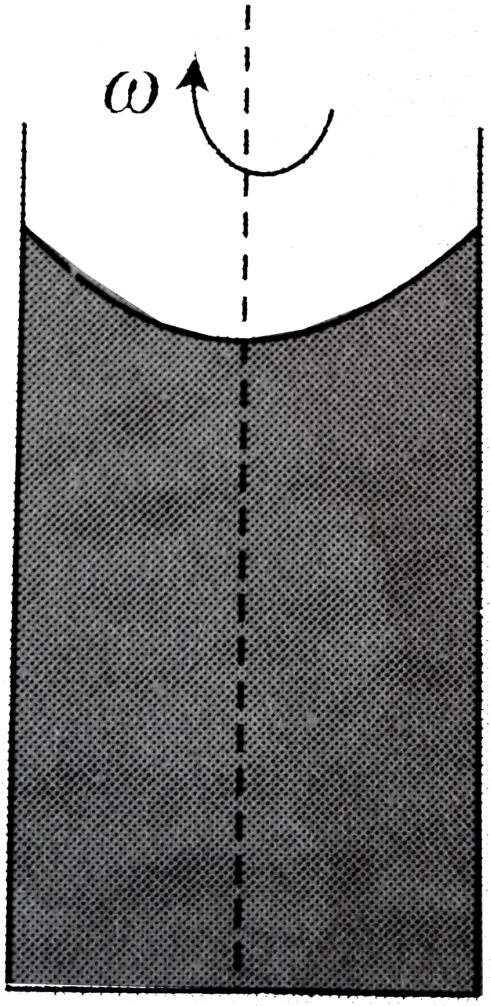
41. A liquid of density ρ is in a vessel rotating with angular velocity ω as shown in figure. If P_0 is the atmospheric pressure, find pressure

at a radial distance r from the axis.



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42. A liquid is kept in a cylindrical vessel which is rotated along its axis. The liquid rises at the sides, if the radius of vessel is $0.05m$ and the speed of rotation is $2rev/s$, find difference in the height of the liquid at the centre of the vessel and its sides.

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Exercises

1. In making an alloy, a substance of specific gravity s_1 and mass m_1 is mixed with another substance of specific gravity of the alloy is

A. $\left(\frac{m_1 + m_2}{s_1 + s_2}\right)$

B. $\left(\frac{s_1 s_2}{m_1 + m_2}\right)$

C. $\frac{m_1 + m_2}{\frac{m_1}{s_1} + \frac{m_2}{s_2}}$

D. $\frac{\frac{m_1}{s_1} + \frac{m_2}{s_2}}{m_1 + m_2}$

Answer: C

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2. A liquid can easily change its shape but a solid can not because

A. the density of a liquid is smaller than that of a solid

B. the forces between the molecules is stronger in solid than in liquids

C. the atoms combine to form bigger molecules in a solid

D. the average separation between the molecules is larger in solids.

Answer: B

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3. Consider the equations

$$P = \lim_{\triangle s \to 0} \frac{F}{\triangle S} \text{ and } P_1 - P_2 = \rho g z$$

In an elevator acceleratin upward

A. both the equations are valid

B. the first is valid but not the second

C. the second in valid but not the first

D. both are invalid

Answer: B

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4. The three vessels shown in figure have same base area. Equal volumes of a liquid are poured in the thre vessels. The force on the

base will be

A. A

B. B

C. C

D. equal in all

Answer: C

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5. Equal mass of three liquids are kept in three identical cuylindrical vessels A, B and C. the densities are ρ_A, ρ_B, ρ_C with $\rho_A < \rho_B < \rho_C$. The force on the base will be

A. A

B. B

C. C

D. equal in all

Answer: D

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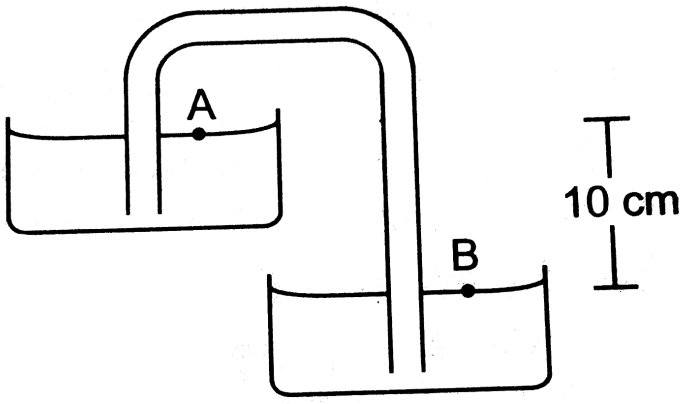
6. Figure shows a siphon. The liquid shown in water. The pressure difference $P_B - P_A$ between the points A and B is



A. $400N/m^2$

B. $3000N/m^2$

C. $100N/m^2$

D. zero

Answer: D

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7. A beaker containing a liquid is kept inside a big closed jar. If the air inside the jar is continuously pumped out, the pressure in the liquid near the bottom of the liquid will

A. increase

B. decrease

C. remain constant

D. first decrease and then increase

Answer: B

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8. If pressure at half the depth of a lake is equal to 2//3 pressure at the bottom of the lake then what is the depth of the lake ?

A. 10 m

B. 20 m

C. 60 m

D. 30 m

Answer: B

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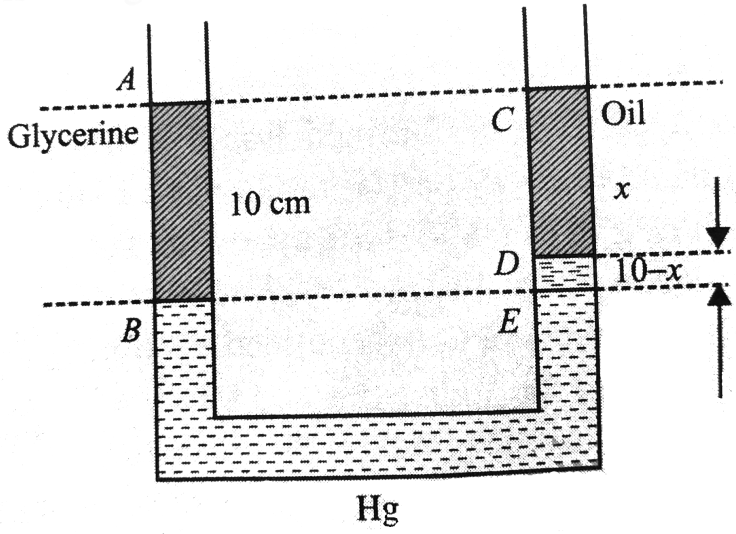
9. A vertical U tube of uniform cross section contains mercury in both of its arms. A glycerine $\left(d = 1.3g/cm^3\right)$ column of length

$10cm$ is introduced into one of the arms. Oil of density $0.8g/cm^3$ is poured in the other arm until the upper surfaces of the oil and glycerine are in the same horizontal level. Find the length of oil column. Densit of mercury is $13.6g/cm^3$.



A. $10.4cm$

B. $8.2cm$

C. $7.2cm$

D. $9.6cm$

Answer: D

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10. In a hydraulic press the small cylinder has a diameter of $'d_1'cm$, while the large piston has a diameter of $'d_2'cm$. If a force $'F_1'$ is

applied to a small piston, the force on the large piston $'F_2'$ is given by.

A. $F_2 = \frac{d_2^2}{d_1^2} F_1$

B. $F_2 = \frac{d_1^2}{d_2^2} F_1$

C. $F_2 = \frac{d_1^2}{d_2^2} \frac{1}{F_1}$

D. $F_2 = \frac{d_1^2}{d_1^2} \frac{1}{F_1}$

Answer: A

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11. An inverted bell lying at the bottom of a lake $47.6m$ deep has $50cm^3$ of air trapped in it. The bell is brought to the surface of the lake. The volume of the trapped air will be (atmospheric pressure $= 70cm$ of Hg and density of $Hg = 13.6g/cm^3$).

A. $350cm^3$

B. $300cm^3$

C. $250cm^3$

D. $22cm^3$

Answer: B

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12. The height to which a cylindrical vessel be filled with a homogenous liquid, to make the average force with which the liquid presses the side of the vessel equal to the force exerted by the liquid on the bottom of the vessel, is equal to.

A. half of the radius of the vessel

B. radius of the vessel

C. one-fourth of the radius of the vessel

D. three-fourth of the radius of the vessel.

Answer: B

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13. A triangular lamina of area A and height h is immersed in a liquid of density ρ in a vertical plane with its base on the surface of the liquid. The thrust on the lamina is.

A. $\frac{1}{2}A\rho gh$

B. $\frac{1}{3}A\rho gh$

C. $\frac{1}{6}A\rho gh$

D. $\frac{2}{3}A\rho gh$

Answer: D

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14. By sucking a straw a student can reduce the pressure in his lungs to $750mm$ of $Hg(\text{density}) = 13.6kg/cm^3)$ Using the

straw, he can drink water from a glass up to a maximum depth of :

A. 10 cm

B. 75 cm

C. $13.6cm$

D. $1.36cm$

Answer: C

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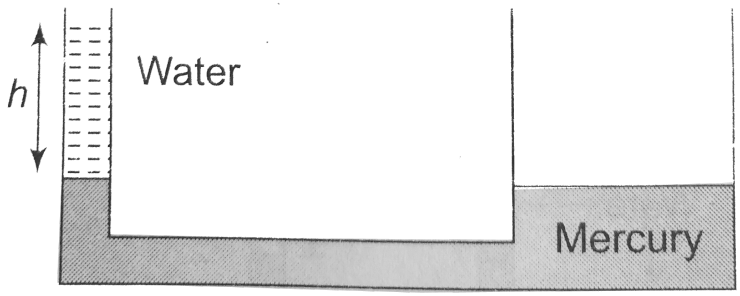
15. Two communicating vessels contain mercury. The diameter of one vessel in n times larger then the diameter of the other. A column of water of height h is poured into the left vessel. The mercury level will rise in the right hand vessel (s = relative density of mercury and ρ = density of water) by



A. $\frac{n^2 h}{(n+1)^2 s}$

B. $\frac{h}{(n^2+1)s}$

C. $\frac{h}{(n+1)^2 s}$

D. $\frac{h}{n^2 s}$

Answer: B

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16. Suppose the pressure at the surface of mercury in as barometer tube is P_1 and the pressure at the surface of mercury in the cup is P_2.

A. $P_1 = 0$, P_2 = atmospheric pressure

B. P_1 = atmospheric pressure, $P_0 = 0$

C. $P_1 = P_2$ = atmospheric pressure

D. $P_1 = P_2 = 0$

Answer: A

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17. To construct a barometer, a tube of length 1m is filled completely with mercury and is inverted ina mercury cup. The barometer

reading on a particular day is 76 cm. Suppose a 1m tube is filled with mercury up to 76 cm and then closed by a cork. It is inverted in a mercury cup and the cork is removed. It is inverted in a mercury column in the tube over the surface in the cup will be

A. zero

B. 76 cm

C. gt 76 cm

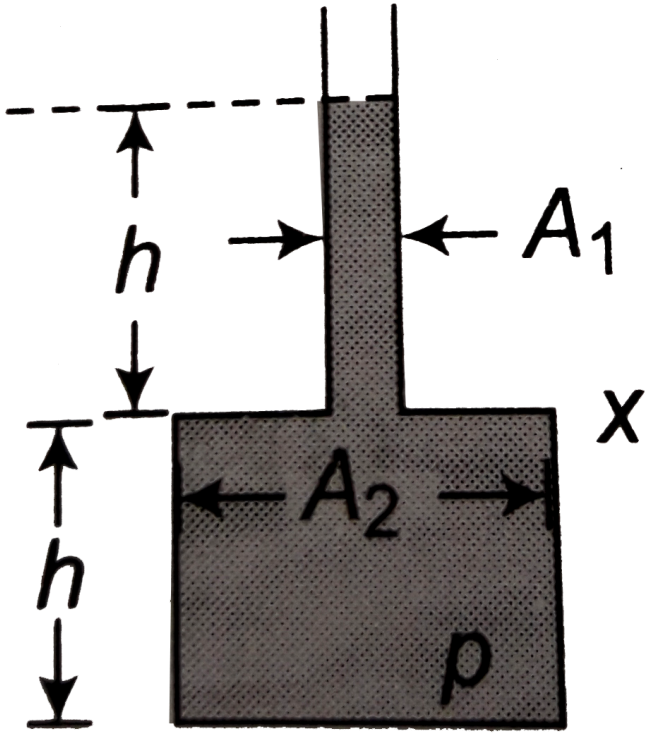
D. lt 76 cm

Answer: D

Watch Video Solution

18. The vessel shown in the figure has a two sections of areas of cross-section A_1 and A_2. A liquid of density ρ fills both th sections, up to a height h in each Neglect atmospheric

pressure. Choose the wrong option.



A. The pressure at the base of the vessel is

$2h\rho g$.

B. The force exerted by the liquid on the base of the vessel is $2h\rho gA_2$

C. The weight of the liquid is $= 2h\rho gA_2$

D. The waals of the vessel at the level X exerted a downward force $h\rho g(A_2 - A_1)$ on the liquid.

Answer: C

Watch Video Solution

19. A beaker containing a liquid of density ρ moves up with an acceleration a. The pressure due to the liquid at a depth h below the free surface of the liquid is.

A. $h\rho g$

B. $h\rho(g+a)$

C. $h\rho(g-a)$

D. $2h\rho g\left(\frac{g-a}{g+a}\right)$

Answer: B

Watch Video Solution

Watch Video Solution

20. The pressure in a liquid at two points in the same horizontal plane are equal. Consider an elevator accelerating upward and a car accelerating on a horizontal road. The above statement is correct in

A. the car only

B. the elevator only

C. both of them

D. neither of them

Answer: B

Watch Video Solution

21. A barometer kept in an elevator accelerating upward reads 76 cm. The air pressure in the elevator is

A. 76 cm

B. lt 76 cm

C. gt 76 cm

D. zero

Answer: C

Watch Video Solution

22. A block of aluminium of mass $1kg$ and volume $3.6 \times 10^{-4}m^3$ is suspended from a string and then completely immersed in a container of water. The decrease in tension in the string after immersion is.

A. $9.8N$

B. $6.2N$

C. $3.6N$

D. $1.0N$

Answer: C

Watch Video Solution

23. A closed cubical box is completely filled with water and is accelerated horizontally towards right with an acceleration a. The resultant normal force by the water on the top of the box.

A. passes through the centre of the top

B. passes through a point to the right of the centre

C. passes through a point to the left of the centre

D. becomes zero

Answer: C

Watch Video Solution

24. A U-tube containing a liquid is accelerated horizontally with a constant acceleration a_0. If the separation between the vertical limbs is l find the difference in the heights of the liquid in the two arms.

A. ad/g

B. $2da/g$

C. $da/2g$

D. $d\tan(a/g)$

Answer: A

Watch Video Solution

25. A sealed tank containing a liquid of density ρ moves with horizontal acceleration a as shown in the figure. The difference in pressure between two points A and B will be

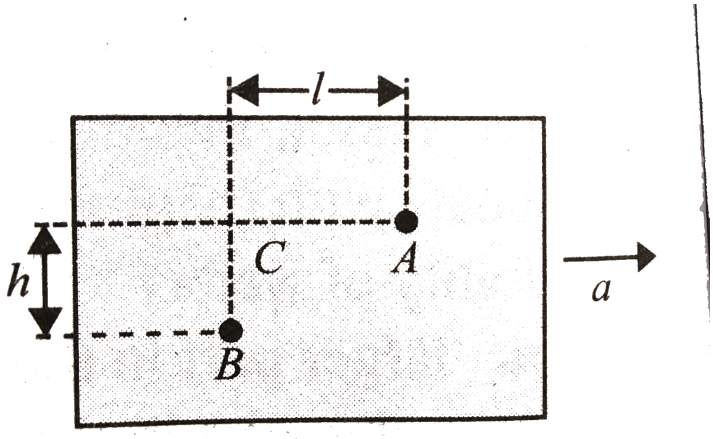


Fig. 4.206

A. $h\rho g$

B. $l\rho a$

C. $h\rho g - l\rho a$

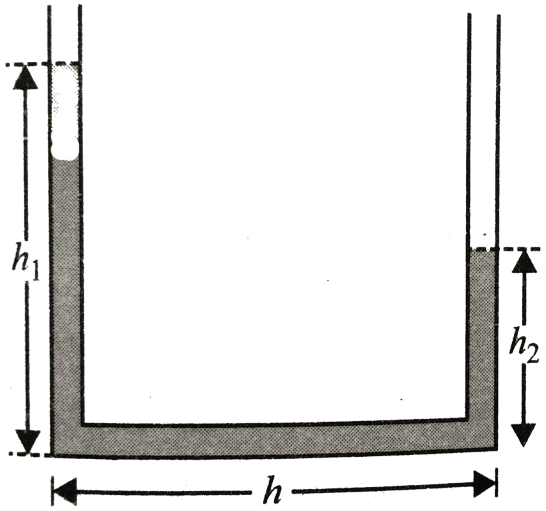
D. $h\rho g + l\rho a$

Answer: D

Watch Video Solution

26. The U-tube shown in the figure has a uniform cross section. A liquid is filled up to heights h_1 and h_2 in the two arms and they

are allowed to move. Neglecting viscosity and surface tension, find the state of the liquid when the levels equalize in the two arms. Find the correct statement.



A. be at rest

B. be moving with an acceleration of

$$g\left(\frac{h_1 - h_2}{h_1 + h_2 + h}\right)$$

C. be moving with a velocity of

$$(h_1 - h_2)\sqrt{\frac{g}{2(h_1 + h_2 + h)}}$$

D. exert a net force to the right on the tube.

Answer: C

Watch Video Solution

27. A vertical $U-tube$ contains a liquid. The total length of the liquid column inside the tibe is 1. When the liquid is in equilibrium, the liquid surface in one of the arms of the $U-tube$ is pushed down slightly and released. The entire liquid column will undergo a periodic motion.

A. The motion is not simple harmonic motion

B. The motion is simple harmonic motion

C. If it undergoes simple harmonic motion, the time period will be $2\pi\sqrt{l/g}$.

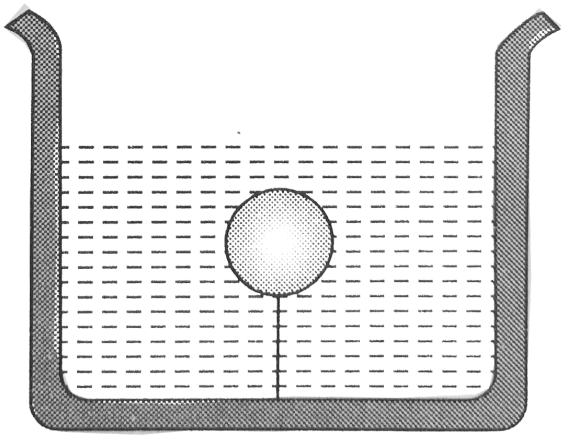
D. If it undergoes simple harmonic motion, the time period will be $2\pi\sqrt{l/2g}$.

Answer: D

Watch Video Solution

28. A solid sphere of density $\eta(>1)$ times lighter than water 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. $\left(\frac{\alpha-1}{\alpha}\right)mg$

B. αmg

C. $\frac{mg}{\alpha-1}$

D. $(\alpha-1)mg$

Answer: D

Watch Video Solution

29. An iceberg of density $900kg/m^3$ is floating in water of density $1000kg/m^3$. The percentage of volume of ice cube outside the water is

A. $20\ \%$

B. $35\ \%$

C. $10\ \%$

D. $25\ \%$

Answer: C

Watch Video Solution

30. A body floats with one-third of its volume outside water and $3/4$ of its volume outside another liquid. The density of another liquid is :

A. $8/3$

B. $2/3$

C. $4/3$

D. $5/3$

Answer: A

Watch Video Solution

31. A body weighs $50g$ in air and $40g$ in water. How much would it weigh in a liquid of specific gravity 1.5

A. 65 g

B. 45 g

C. 30 g

D. 35 g

Answer: D

Watch Video Solution

32. A raft of wood (density $= 600kg/m^3$) of mass $120kg$ floats in water. How much weight can be put on the raft to make it just sink?

A. 80 kg

B. 50 kg

C. 60 kg

D. 30 kg

Answer: A

Watch Video Solution

33. A vessel contains oil (density $= 0.8 gm / cm^3$) over mercury (density $= 13.6 gm cm^3$). A homogeneous sphere

floats with half its volume immersed in mercury and the other half in oil. The density of the material of the sphere in gm/cm^3 is

A. 3.3

B. 6.4

C. 7.2

D. 12.8

Answer: C

Watch Video Solution

34. A thin uniform cylindrical shell, closed at both ends, is partially filled with water. It is floating vertically in water in half-submerged state. If ρ_c is the relative density of the material of the shell with respect to water, then the correct statement is that the shell is

A. More than half filled if ρ_c is less then 0.5

B. More than half filled if ρ_c is less then 1.0

C. Half filled if ρ_c is less than 0.5

D. Less than half filled if ρ_c is less than 0.5

Answer: D

Watch Video Solution

35. A concrete sphere of radius R has cavity of radius r which is packed with sawdust. The specific gravities of concrete and sawdust are respectively $2.4 \text{ and } 0.3$ for this sphere to float with its entire volume submerged under water. Ratio of mass of concrete to mass of swadust will be

A. 8

B. 4

C. 3

D. zero

Answer: B

Watch Video Solution

36. A body of density d is counterpoised by Mg of weights of density d_1 in air of density d. Then the true mass of the body is

A. M

B. $M\left(1\frac{d}{d_2}\right)$

C. $M\left(1-\frac{d}{d_1}\right)$

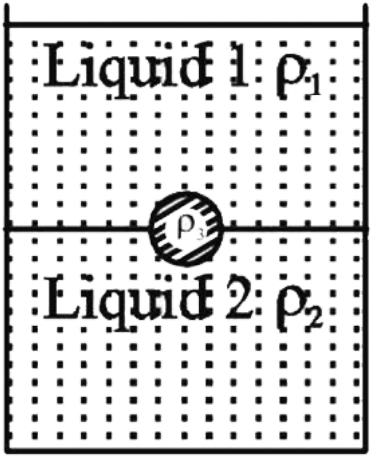
D. $\frac{M(1-d/d_2)}{(1-d/d_1)}$

Answer: D

Watch Video Solution

37. A jar is filled with two non-mixing liquids 1 and 2 haivng densities ρ_1 and ρ_2 respectively. A solid ball, made of a material of density ρ_3 ,

is dropped in the jar. It comes to equilibrium in the position shown in the figure. Which of the following is true for ρ_1, ρ_1 and ρ_3?



A. $\rho_1 > \rho_3 > \rho_2$

B. $\rho_1 > \rho_2 > \rho_3$

C. $\rho_1 < \rho_3 < \rho_2$

D. $\rho_1 < \rho_1 < \rho_2$

Answer: C

Watch Video Solution

38. A solid is completely immersed in a liquid. The force exerted by the liquid on the solid will

A. (i),(ii)

B. (ii),(iii)

C. (iii),(iv)

D. (i),(iv)

Answer: C

Watch Video Solution

39. A uniform rod of density ρ is placed in a wide tank containing a liquid of density $\rho_0(\rho_0 > \rho)$. The depth of liquid in the tank is half the length of the rod. The rod is in equilibrium, with its lower end resting on the bottom of the tank. In this position the rod makes an angle θ with the horizontal.

A. $\sin\theta = \frac{1}{2}\sqrt{\rho_0/\rho}$

B. $\sin\theta = \frac{1}{2}.\frac{\rho_0}{\rho}$

C. $\sin\theta = \sqrt{\rho_0/\rho}$

D. $\sin\theta = \rho/\rho_0$

Answer: A

Watch Video Solution

40. A body is just floating in a liquid (their densities are equal). If the body is slightly pressed down and released it will :

A. It will slowly come back to its earlier position

B. It will remain submerged, where it is left

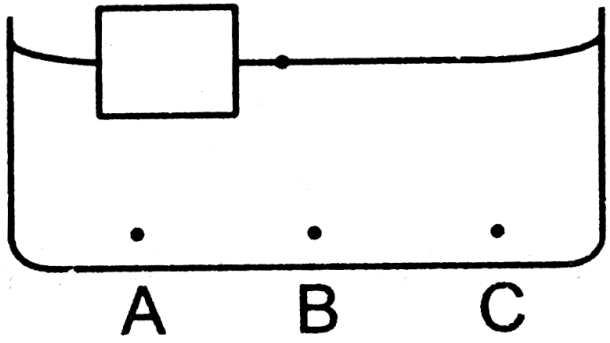
C. It will sink

D. It will come out violently

Answer: B

 Watch Video Solution

41. A wooden object floats in water kept in as beaker. The object is near a side of the beaker figure. Let P_1, P_2, P_3 be the pressure at the three points A,B and C of the bottom as shown in the figure.



A. $P_1 = P_2 = P_3$

B. $P_1 < P_2 < P_3$

C. $P_1 > P_2 > P_3$

D. $P_2 + P_3 \neq P_1$

Answer: A

Watch Video Solution

42. A meta cube is plced in an empty vessel. When water is filed in the vessel so that the cubeis completely immersed in the water, the fore on the bottom of the vessel in contact with the cube

A. will increase

B. will decrease

C. will remain the same

D. will become zero

Answer: C

Watch Video Solution

43. A cork is submerged in water by a spring attached to the bottom of a bowl. When the

bowl is kept in an elevator moving with acceleration downwards, the length of spring.

A. increases

B. decreases

C. remain unchanged

D. none of these

Answer: B

 Watch Video Solution

44. A piece of wood is floating in water kept in a bottle. The bottle is connected to an air pump. Neglect the compressibility of water. When more air is pushed into the bottle from the pump, the piece of wood will float with

A. larger part in the water

B. lesser part in the water

C. same part in the water

D. it will sink

Answer: C

Watch Video Solution

45. A piece of wood floats in water kept in a beaker. If the beaker moves with a vertical acceleration a, the wood will.

A. sink deeper in the liquid if a is upward

B. sink deeper in the liquid if a is downward, with $a < g$

C. come out more from the liquid if a is downward, with $a < g$

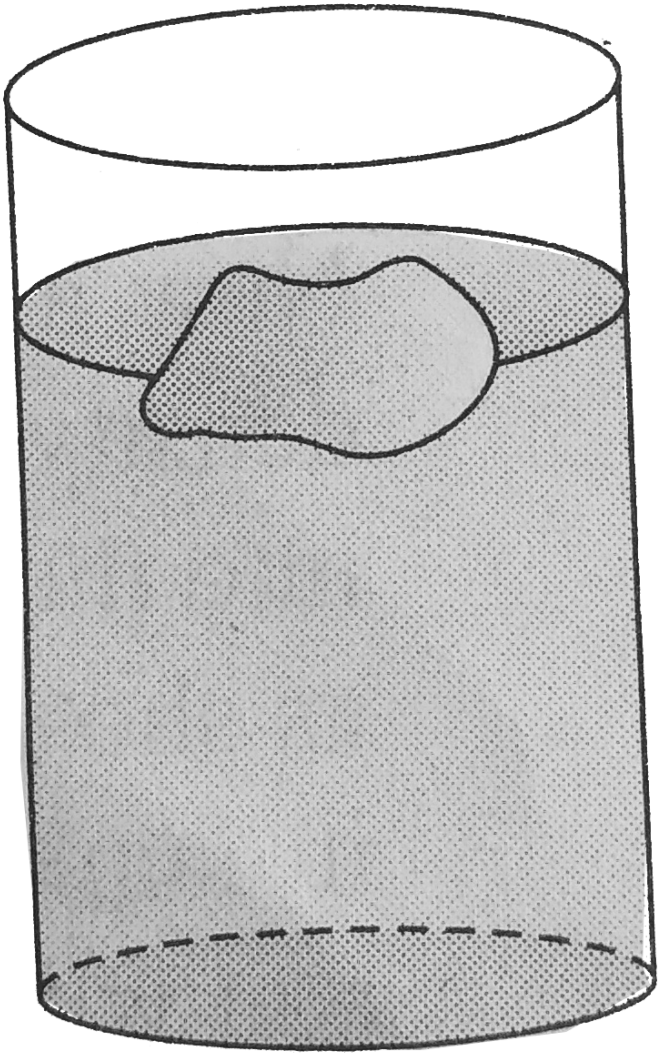
D. remain in the same position relative to the water.

Answer: D

View Text Solution

46. A body floats in a liquid contained in a beaker. The whole system as shown falls freely under gravity. The upthrust on the body due

to the liquid is



A. zero

B. equal to the weight of the liquid displaced

C. equal to the weight of the body in air

D. equal to the weight of the immersed portion of the body

Answer: A

 Watch Video Solution

47. A man is carrying a block of a certain substance (of density $1000kgm^{-3}$) weighing $1kg$ in his left hand and a bucket filled with water and weighing $10kg$ in his right hand. He drops the block into the bucket. How much load does he carry in his right hand now.

A. 9 kg

B. 10 kg

C. 11 kg

D. 12 kg

Answer: C

Watch Video Solution

48. A block of ice is floating in a liquid of specific gravity 1.2 contained in the beaker. What will be the effect on the level of liquid in the beaker when the whole ice melts?

A. remains same

B. rises

C. lowers

D. (1),(2) or (3)

Answer: B

Watch Video Solution

49. Ice pieces are floating in a beaker A containing water and also in a beaker B containing miscible liquid of specific gravity 1.2 When ice melts, the level of

A. water increases in A

B. water decreases in A

C. liquid in B decreases

D. liquid in B increases

Answer: D

Watch Video Solution

50. A boat carrying steel balls is floating on the surface of water in a tank. If the balls are thrown into the tank one by one, how will it affect the level of water ?

A. it will remain unchanged

B. it will rise

C. It will fall

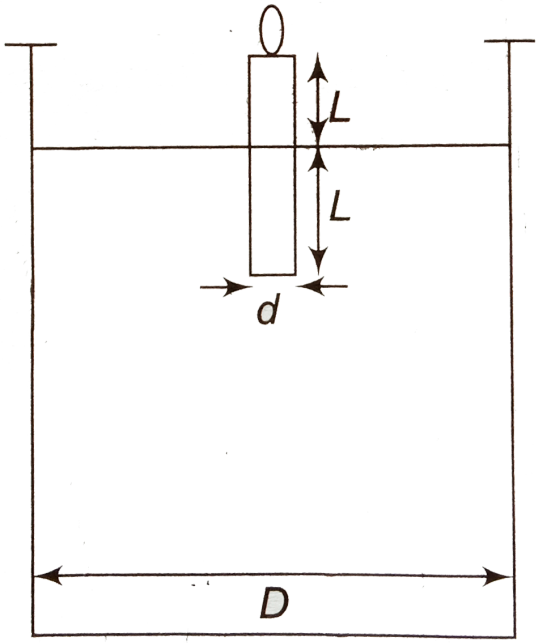
D. First it will rise and then fall

Answer: C

Watch Video Solution

51. A candle of diameter d is floating on a liquid in a cylindrical container of diameter $D(D << d)$ as shown in figure. If is burning

at the rate of $2cm/h$ then the top of the candle will :



A. remain at the same height

B. fall at the rate of $1cm/hour$

C. fall at the rate of $2cm/hour$

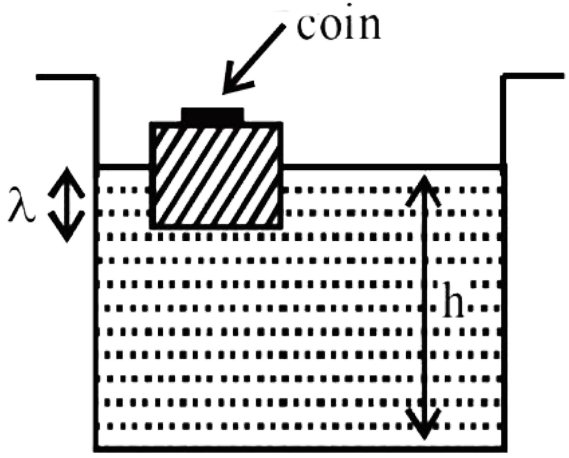
D. go up the rate of $1cm/hour$

Answer: B

Watch Video Solution

52. A wooden block, with a coin placed on its top, floats in water as shown in figure. The distance l and h are shown here. After some

time the coin falls into water. Then



A. l decreases and h increases

B. l increases and h decreases

C. both l and h increase

D. both l and h decrease

Answer: D

Watch Video Solution

53. A rectangular block of mass m and area of cross-section A floats in a liquid of density ρ. If it is given a small vertical displacement from equilibrium, it undergoes oscillation with a time period T.

(i) $T \propto \sqrt{m}$

(ii) $T \propto \sqrt{\rho}$

(iii) $T \propto \dfrac{1}{\sqrt{A}}$

(iv) $T \propto \dfrac{1}{\sqrt{\rho}}$.

A. (i),(ii),(iii)

B. (i),(iii),(iv)

C. (i),(iii)

D. (iii),(iv)

Answer: B

Watch Video Solution

54. A spring balance reads W_1 when a ball is suspended from it. A weighing machine reads W_2 when a tank of liquid is kept on it. When

the ball is immersed in the liquid, the spring balance reads W_3 and the weighing machine reads W_4. Then, which of the following are not correct?

A. (i),(iii)

B. (i),(iv)

C. (ii),(iii)

D. (ii),(iv)

Answer: A

Watch Video Solution

55. In the previous question,

A. $W_1 + W_2 = W_3 + W_4$

B. $W_1 + W_3 = W_2 + W_4$

C. $W_1 + W_4 = W_2 + W_3$

D. $W_1 + W_2 + W_3 = W_4$

Answer: A

Watch Video Solution

56. A massless conical flask filled with a liquid is kept on a table in a vacuum. The force exerted by the liquid on the base of the flask is W_1. The force exerted by the flask on the table is W_2.

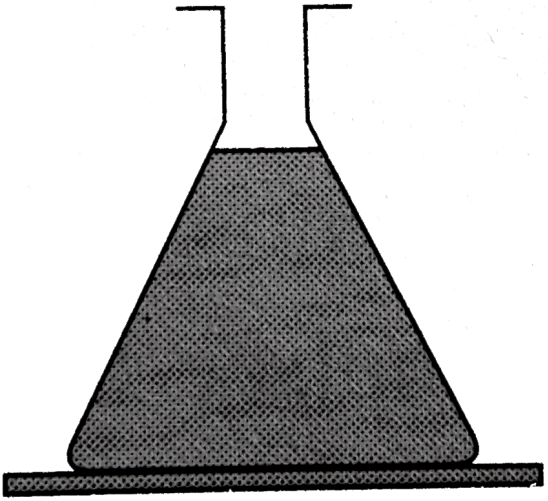
(i) $W_1 = W_2$

(ii) $W_1 > W_2$

(iii) $W_1 < W_2$

(iv)The force exerted by the liquid on the walls

of the flask is $(W_1 - W_2)$.



A. (i),(iv)

B. (ii),(iv)

C. (iii),(iv)

D. (iii)

Answer: B

View Text Solution

57. A $20N$ metal block is suspended by a spring balance. A beaker containing some water is placed on a weighing machine which reads $40N$. The spring balance is now lowered so that the block gets immersed in the water. The spring balance now reads $16N$. The reading of the weighing machine will be.

A. 36 N

B. 60 N

C. 44 N

D. 56 N

Answer: C

Watch Video Solution

58. The weight of an empty balloon on a spring balance is W_1. The weight becomes W_2 when the balloon is filled with air.Let the

weight of the air itself be w.l Neglect the thickness of the balloon when it is filled with air. Also neglect the difference in the density of air insider and outside the balloonn

A. $W_2 = W_1$

B. $W_2 = W_1 + \omega$

C. $W_2 < W_1 - \omega$

D. $W_2 > W_1$

Answer: A

Watch Video Solution

59. The weight of a balloon is W_1 when empty and W_2 when filled with air. Both are weighed in air by the same sensitive spring balance and under identical conditions.

A. $W_1 = W_2$, as the weight of air in the balloon is offset by the force of buoyancy on it.

B. $W_2 < W_1$ due to the force of buoyancy acting on the filled balloon.

C. $W_2 > W_1$, as the air inside is at a greater pressure and hence has greater density than the air outside.

D. $W_2 = W_1 +$ weight if the air inside it.

Answer: C

View Text Solution

60. Bernoulli's equation is a consequence of conservation of

A. conservation of energy only

B. conservation of momentum only

C. conservation of angular momentum only

D. more than one of the above

Answer: A

Watch Video Solution

61. According to Bernoulli's equation

$$\frac{P}{\rho g} + h + \frac{1}{2}\frac{v^2}{g} = \text{constant}$$

The terms A, B and C are generally called respectively.

A. Gravitational head, pressure head and velocity head

B. Gravity, gravitational head and velocity head

C. Pressure head, gravitational head and velocity head

D. none of these

Answer: C

Watch Video Solution

62. The working of an atomizer depends upon

A. Bernoulli's theorem

B. Boyle's law

C. Archimedes principle

D. Newton's law of motion

Answer: A

View Text Solution

63. The weight of an aeroplane flying in the air is balanced by.

A. vertical component of the thrust created by air currents striking the lower surface of the wings

B. force due to reaction of gasses ejected by the revolving propeller

C. upthrust of the air which will be equal to the weight of the air having the same

volume as the plane.

D. force due to the pressure difference between the upper and lower surfaces of the wings created by different air speeds on the surfaces.

Answer: D

View Text Solution

64. In a streamline flow,

(i) the speed of a particle always remains same

(ii) the velocity of a particle always remains same

(iii) the kinetic energies of all the particles arriving at a given point are the same

(iv) the momenta of all the particles arriving at a given point are the same.

A. (i),(iii)

B. (ii),(iii)

C. (i),(iii)

D. (iii),(iv)

Answer: D

View Text Solution

65. There is a small hole near the botton of an open tank filled with liquid. The speed of the water ejected does not depend on

A. (i),(ii)

B. (i),(iii)

C. (i),(iv)

D. (ii),(iv)

Answer: A

Watch Video Solution

66. Water and mercury are filled in towi cylinderical vessels up to same height. Both vesels hve a hole in thewal near the bottom. The velocity of water and mercury coming out of the holes are v_1 and v_2 respectively.

A. $v_1 = v_2$

B. $v_1 = 13.6 v_2$

C. $v_1 = v_2 / 13.6$

D. $v_1 = \sqrt{13.6} v_2$

Answer: A

Watch Video Solution

67. Water enters through end A with a speed v_1 and leaves through end B with a speed v_2 of cylindrical tube AB. The tube is always

completely filled with water. In case I the tube is horizontal, in case II it vertical with the end A upward and in case III it is vertical with the end B upward. We have $v_1 = v_2$for

A. case I

B. case II

C. case III

D. each case

Answer: D

Watch Video Solution

68. Water is flowing through a long horizontal tube. Let P_A and P_B be the pressures at two points A and B of the tube

A. P_A must be equal to P_B.

B. P_A must be greater than P_B,

C. P_A must be smaller than P_B,

D. $P_A = P_B$ only if the cross-sectional area at A and B are equal.

Answer: A

Watch Video Solution

69. Water is flowign is streamline motion through a tube with its axis horizontal. Consider two points A and B in the tube at the same horizontal level

A. (i),(iii)

B. (ii),(iii)

C. (i),(iv)

D. (iii),(iv)

Answer: D

Watch Video Solution

70. A closed vessel is half filled with water. There is a hole near the top of vessel and air is pumped out from this hole.

A. (i),(ii)

B. (i),(iii)

C. (ii),(iii)

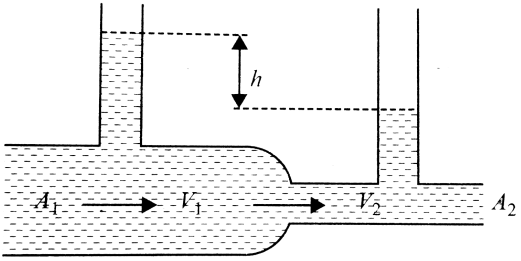
D. (i),(iv)

Answer: C

Watch Video Solution

71. A liquid flows through a horizontal tube. The velocities of the liquid in the two sections, which have areas of cross section A_1 and A_2 are v_1 and v_2 respectively. The difference in the levels of the liquid in the two vertical

tubes is h. Then



A. (i),(ii)

B. (i),(iii)

C. (i),(iii),(iv)

D. (iii),(iv)

Answer: C

Watch Video Solution

72. The cylindrical tube of a spray pump has a cross-section of $8cm^2$, one end of which has 40 fine holes each of area $10^{-8}m^2$. If the liquid flows inside the tube with a speed of $0.15m\ \min^{-1}$, the speed with which the liquid is ejected through the holes is.

A. $50ms^{-1}$

B. $5ms^{-1}$

C. $0.65ms^{-1}$

D. $0.5ms^{-1}$

Answer: B

Watch Video Solution

73. There is a small hole at the bottom of tank filled with water. If total pressure at the bottom is $3atm\left(1atm = 10^5 Nm^{-2}\right)$, then find the velocity of water flowing from hole.

A. $\sqrt{400}m/s$

B. $\sqrt{600}m/s$

C. $\sqrt{60}m/s$

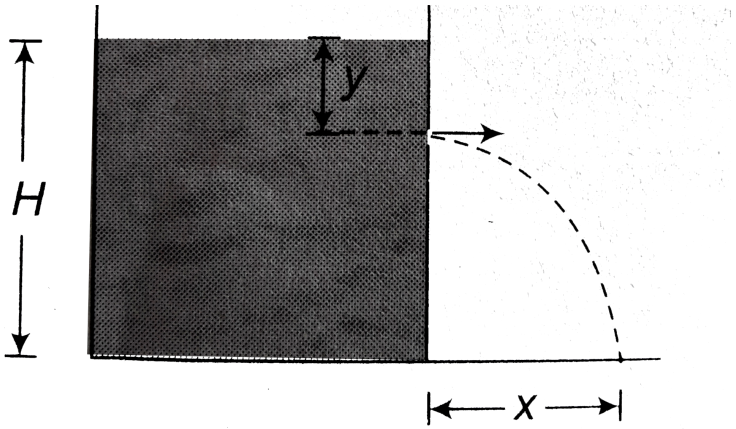
D. None of these

Answer: A

Watch Video Solution

74. A tank which is open at the top, contains a liquid up to a height H. A small hole is made in the side of the tank at a distance y below the liquid surface. The liquid emerging from the hole lands at a distance x from the tank.

Choose incorrect option.



A. If y is increased from zero to H, x will first increase and then decrease

B. x is maximum for $y = H/2$

C. The maximum value of x is H

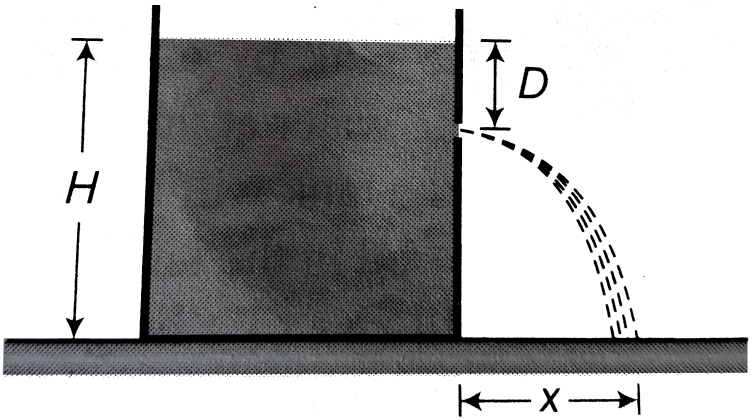
D. The maximum value of x will depend on the density of the liquid.

Answer: D

View Text Solution

75. A tank is filled with water up to a height H. Water is allowed to come out of a hole P in one of the walls at a depth D below the surface of water. Express the horizontal

distance x in terms of H and D



A. $x = \sqrt{D(H - H)}$

B. $x = \sqrt{\dfrac{D(H - D)}{2}}$

C. $x = 2\sqrt{D(H - D)}$

D. $x = 4\sqrt{D(H - D)}$

Answer: C

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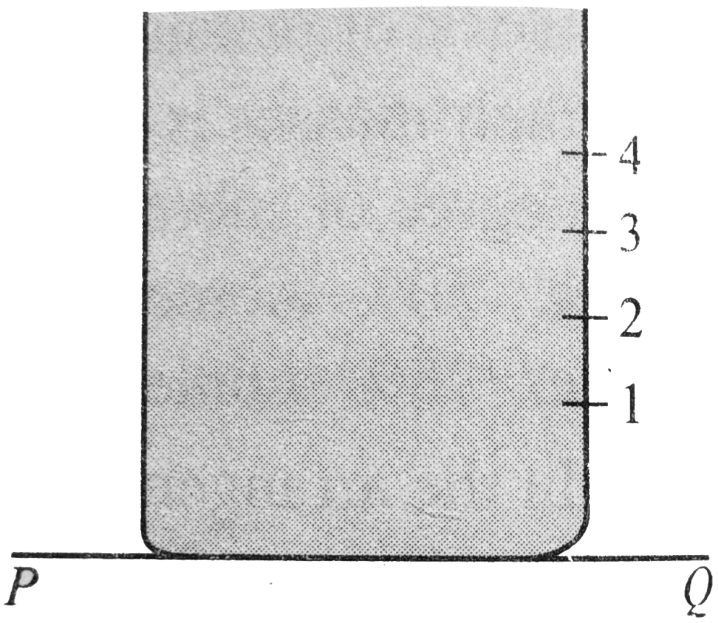
76. A cylindrical vessel of $90cm$ height is kept filled up to the brim. It has four holes $1, 2, 3$ and 4 which are, respectively, at heights of $20cm, 30cm, 40cm$ and $50cm$ from the horizontal floor PQ. The water falling at the maximum horizontal distance from the vessel

comes from



A. hole number 4

B. hole number 3

C. hole number2

D. hole number 1

Answer: B

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77. 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. $2\pi L$

B. $\frac{L}{\sqrt{2\pi}}$

C. L

D. $\frac{L}{2\pi}$

Answer: B

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78. Water falls from a top, down the streamline

A. Area decreases

B. Area increases

C. Velocity remains same

D. Area remains same

Answer: A

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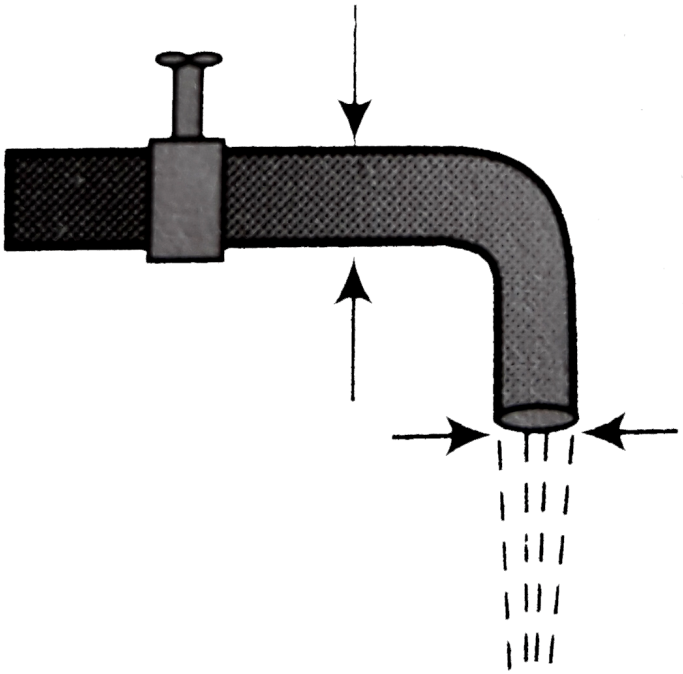
79. Water coming out of the mouth of a tap and falling vertically in streamline flow forms a tapering column, i.e., the area of cross-section of the liquid column decreases as it moves

down. Which of the following is the most accurate explanation for this ?



A. As the water down, its speed increases and hence its pressure decreases. It is then compressed by the atmosphere.

B. Falling water tries to reach a terminal velocity and hence reduces the area of cross-section to balance upward and downward forces.

C. The mass of water flowing past any cross-section must remain constant. Also, water is almost incompressible. Hence, the rate volume flow must remain constant. As this is equal to velocity $\times$

area, the area decrease as velocity increases.

D. The surface tension causes the exposed surface area of the liquid to decrease continuosly.

Answer: C

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80. In the previous question, at the mouth of the tap the area of cross-section is $2.5cm^2$ and the speed of water in $3m/s$. The area of cross-section of the water column $80cm$ below the tap is.

A. $2cm^2$

B. $1.5cm^2$

C. $1cm^2$

D. $0.5cm^2$

Answer: B

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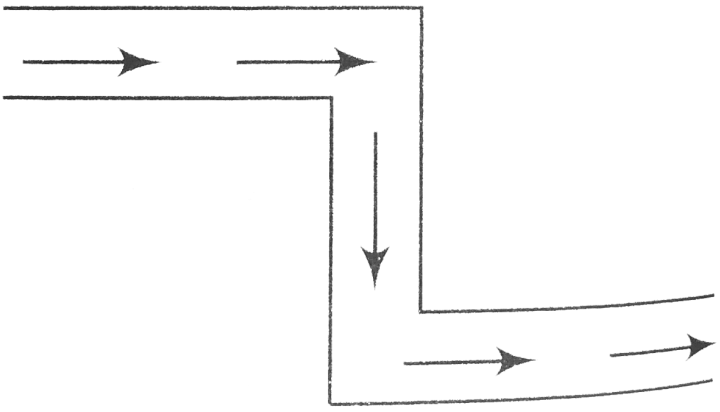
81. The tube shown in figure is of uniform cross-section. Liquid flows through it at a constant speed in the direction shown by arrows. Then the liquid exerts on the tube is:



A. a net force to the right

B. a net force to the left

C. a clockwise torque

D. an anticlockwise torque

Answer: C

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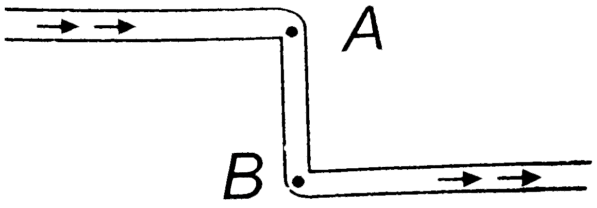
82. In the figure, an ideal flows through the tube, which is of uniform cross-section. The liquid has velocities v_A and v_B and pressures p_A and p_B at points A and B respectively.

(i) $v_A = v_B$

(ii) $v_B > v_A$ ltbr gt (iii) $p_A = p_B$

(iv) $p_B > p_A$.



A. (i),(iii)

B. (i),(iv)

C. (ii),(iii)

D. (ii),(iv)

Answer: B

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83. A liquid is kept in a cylindrical vessel which is being rotated about a vertical axis through the centre of the circular base. If the radius of the vessel is r and angular velocity of rotation is ω, then the difference in the heights of the liquid at the centre of the vessel and the edge is.

A. $\frac{r\omega}{2g}$

B. $\frac{r^2\omega^2}{2g}$

C. $\sqrt{2gr\omega}$

D. $\frac{\omega^2}{2gr^2}$

Answer: B

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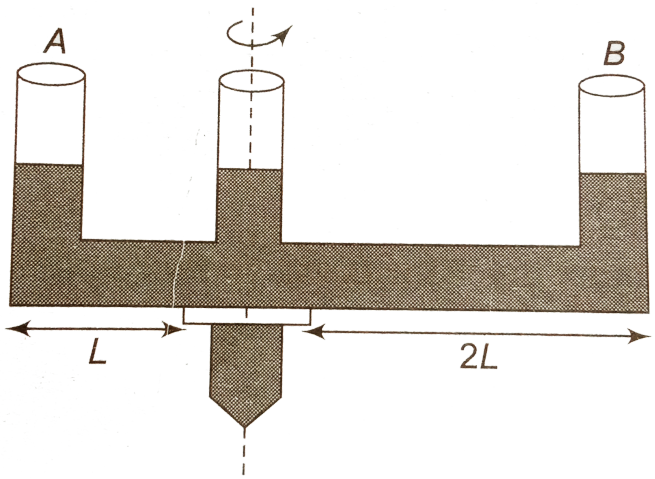
84. A given shaped glass tube having uniform cross-section is filled with water and is mounted on a rotatable shaft as shown in

figure. If the tube is rotated with a constant angular velocity ω then :



A. water levels in both section A and B go up

B. water level in section A goes up and that in B comes down

C. water level in section A comes down and that in B goes up

D. water levels remain same in both sections

Answer: A

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85. Water floows through two identical tubes A and B. A volume V_0 of water passes through

the tube A and $2V_0$ through B in a given time.

Which of the following may be correct?

A. Flow in both the tubes are steady

B. Flow in both the tubes are turbulent

C. Flow is steady in A but turbulent in B

D. Flow is steady in B but turbulent in A

Answer: D

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86. A liquid of density ρ comes out with a velocity v from a horizontal tube of area of cross-section A. The reaction force exerted by the liquid on the tube is F. Choose the incorrect option.

A. $F \propto v$

B. $F \propto v^2$

C. $F \propto A$

D. $F \propto \rho$

Answer: A

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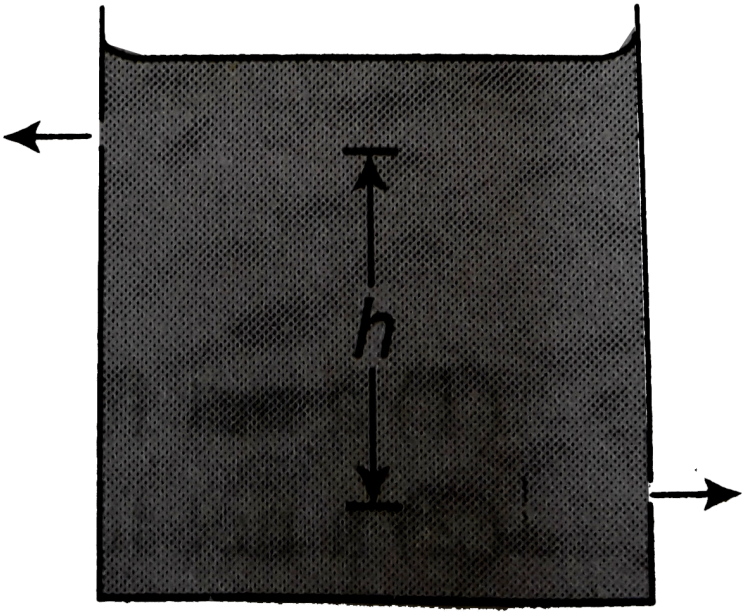
87. There are two identical small holes on the opposite sides of a tank containing a liquid. The tank is open at the top. The difference in height between the two holes is h. As the liquid comes out of the two holes. The tank will experience a net horizontal force

proportional to.



A. $\sqrt{h}$

B. h

C. $h^{3/2}$

D. h^2

Answer: B

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88. An engine pumps water continously through a hose. Water leave the hose with a velocity v and m is the mass per unit length of the Water jet. What is the rate at Which kinetic energy is imparted to water?

A. $\frac{1}{2}mv^3$

B. mv^3

C. $\frac{1}{2}mv^2$

D. $\frac{1}{2}m^2v^3$

Answer: A

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89. A cylindrical drum, open at the top, contains 30 litres of water. It drains out through a small opening at the bottom. 10 litres of water comes out in time t_1, the next

10litres in a further time t_1 and the last 10 litres in a further time t_3 Then,

A. $t_1 = t_2 = t_3$

B. $t_1 > t_2 > t_3$

C. $t_1 < t_2 < t_3$

D. $t_2 > t_1 = t_3$

Answer: C

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90. A large tank is filled with water to a height H. A small hole is made at the base of the tank. It takes T_1 time to decrease the height of water to $\frac{H}{\eta}(\eta > 1)$, and it takes T_2 times to take out the rest of water. If $T_1 = T_2$, then the value of η is

A. 2

B. 3

C. 4

D. $2\sqrt{2}$

Answer: C

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91. A cylindrical tank has a hole of $1cm^2$ in its bottom. If the water is allowed to flow into the tank from a tube above it at the rate of $70cm^3/\sec$, then the maximum height up to which water can rise in the tank is

A. 2.5 cm

B. 5 cm

C. 10 cm

D. 0.25 cm

Answer: A

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92. A large cylindrical tank has a hole of area A at its bottom. Water is oured in the tank by a tube of equal cross sectional area A ejecting water at the speed v.

A. The water level in the tank will keep on rising

B. No water can be stored in the tank

C. The water level will rise to a height $v^2 / 2g$ and then stop.

D. The water level will oscillate.

Answer: C

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93. A cylindrical vessel of height 500mm has an orifice (small hole) at its bottom. The orifice is initially closed and water is filled in it up to height H. Now the top is completely sealed with a cap and the orifice at the bottom is opened. Some water comes out from the orifice and the water level in the vessel becomes steady with height of water column being 200mm. Find the fall in height(in mm) of water level due to opening of the orifice.

[Take atmospheric pressure $= 1.0 \times 10^5 N/m^2$, density of

water=1000kg//m^3 and g=10m//s^2`. Neglect any effect of surface tension.]

A. 5 mm

B. 6 mm

C. 2 mm

D. 1 mm

Answer: B

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