DPP – 3

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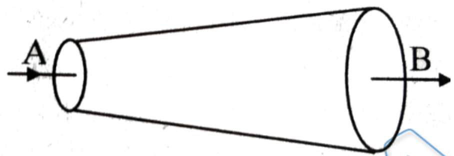
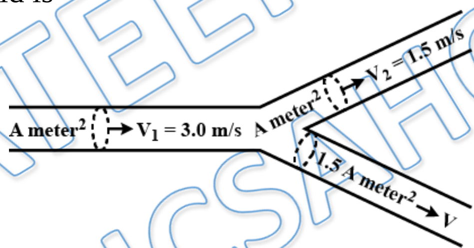
Q 1. An ideal fluid flows through a pipe of circular cross section with diameter 5cm and 10cm as shown. The ratio of velocities of fluid at A and B is



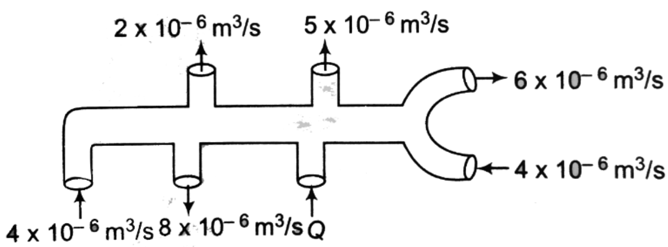
(a) 4 : 1 (b) 1 : 4
(c) 2 : 1 (d) 1 : 2

Q 2. An incompressible liquid flows through a horizontal tube as shown in figure. Then the velocity 'v' of the fluid is



(a) 3 m/s (b) 1.5 m/s
(c) 1 m/s (d) 2.25 m/s

Q 3. The pipe shows the volume flow rate of an ideal liquid at certain time and its direction. What is the value of Q in m^3/s? (Assume steady state and equal area of cross section at each opening)



(a) 10×10^{-6} (b) 11×10^{-6}
(c) 13×10^{-6} (d) 18×10^{-6}

Q 4. Water is moving with a speed of 5.18 m/s through a pipe with a cross-sectional area of 4.20 cm^2. The water gradually descends 9.66 m as the pipe increase in area to 7.60 cm^2. The speed of flow at the lower level is

(a) 3 m/s (b) 5.7 m/s
(c) 3.82 m/s (d) 2.86 m/s

Q 5. The cross-sectional area of water pipe entering the basement is $4 \times 10^{-4}\ m^2$. The pressure at this point is $3 \times 10^5\ N/m^2$ and the speed of water is 2 m/s. This pipe tapers to a cross-sectional area of $2\ \times 10^{-4}\ m^2$ when it reaches the second floor 8 m above the basement. Calculate the speed and pressure of water flow at the second floor (g = 10 m/s^2)

(a) 4 m/s, $2.14 \times 10^5\ N/m^2$
(b) 2 m/s, $1.05 \times 10^5\ N/m^2$
(c) 4 m/s, $1.05 \times 10^5\ N/m^2$
(d) 2 m/s, $2.05 \times 10^5\ N/m^2$

Q 6. Water from a tap emerges vertically downward with an initial speed of 1.0 m/s. The cross-sectional area of the tap is $10^{-4}\ m^2$. Assume that the flow is steady. What is the cross-sectional area of the stream 0.15 m below the tap? Use g = 10 m/s^2

(a) $5 \times 10^{-5}\ m^2$ (b) $4 \times 10^{-4}\ m^2$
(c) $3 \times 10^{-3}\ m^2$ (d) $2 \times 10^{-2}\ m^2$

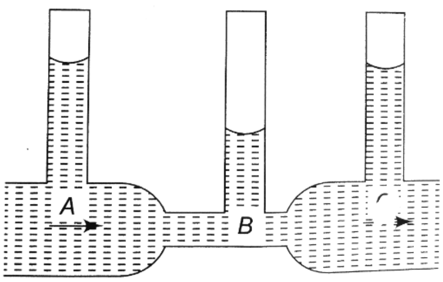
Q 7. A horizontal pipeline carries water in a streamline flow. At a point along the pipe, where the cross-sectional area is 10 cm^2, the water velocity is 1 m/s and the pressure is 2000 Pa. The pressure of water at another point where the cross-sectional area is 5 cm^2, is........Pa. (Density of water = 10^3 kg/m^3)

(a) 200 Pa (b) 1000 Pa
(c) 500 Pa (d) 800 Pa

Q 8. Water 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 0.02 m^2 and velocity of flow is 2m/s. The pressure at a point where cross-section reduces to 0.01 m^2 is 3.4×10^n Pa. What is the value of n ?

(a) 2 (b) 3
(c) 4 (d) 5

Q 9. In the following fig. is shown the flow of liquid through a horizontal pipe. Three tubes A, B and C are connected to the pipe. The radii of the tubes A, B and C at the junction are respectively 2 cm, 1 cm and 2 cm. It can be said that the

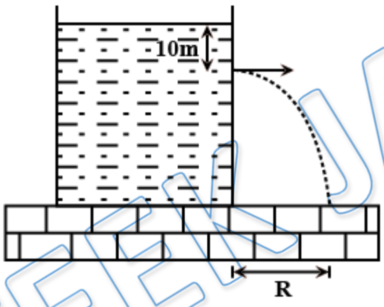


(a) Height of the liquid in the tube A is minimum

(b) Height of the liquid in the tubes A and B is the same
(c) Height of the liquid in all the three tubes is the same
(d) Height of the liquid in the tubes A and C is the same

Q 10. A manometer connected to a closed tap reads 3.5×10^5 N/m^2. When the valve is opened, the reading of manometer falls to 3.0×10^5 N/m^2, then velocity of flow of water is
(a) 100 m/s (b) 10 m/s
(c) 1 m/s (d) $10\sqrt{10}$ m/s

Q 11. A large tank is filled with water (density = 10^3 kg/m^3). A small hole is made at a depth 10m below water surface. the range of water issuing out of the hole is R on ground. What extra pressure must be applied on the water surface so that the range becomes 2R (take 1 atm = 10^5 Pa and g = 10 m/s^2)



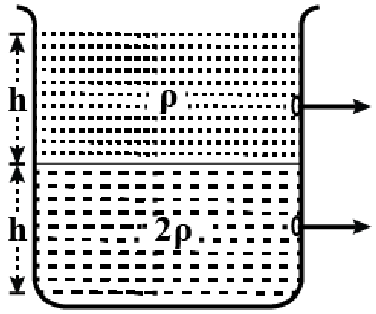
(a) 9 atm (b) 4 atm
(c) 5 atm (d) 3 atm

Q 12. There is a hole in the bottom of tank having water. If total pressure at bottom is 3 atm (1 atm = 10^5 N/m^2) then the velocity of water flowing from hole is
(a) $\sqrt{400}\ m/s$ (b) $\sqrt{600}\ m/s$
(c) $\sqrt{60}\ m/s$ (d) none of these

Q 13. There is a hole of area A at the bottom of cylindrical vessel. Water is filled up to a height h and water flows out in t second. If water is filled to a height 4h, it will flow out in time equal to
(a) t (b) 4t
(c) 2t (d) $\frac{t}{4}$

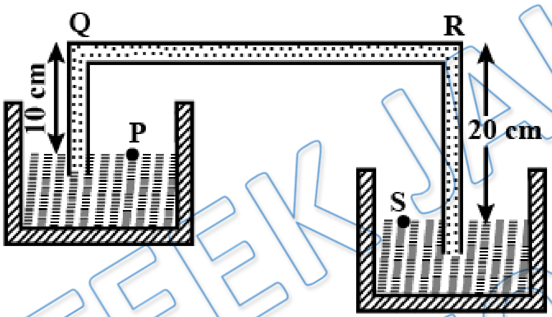
Q 14. A cylindrical tank of height 0.4m is open at the top and has a diameter 0.16m. Water is filled in it up to height of 0.16m. Find the time taken to empty the tank through a hole of radius $5\times10^{-3}\ m$ in its bottom. (g = 9.8 m/s^2)
(a) 21.2 s (b) 46.3 s
(c) 18.7 s (d) 51.1 s

Q 15. Equal volumes of two immiscible liquids of densities ρ and 2ρ are filled in a vessel as shown in figure. Two small holes are punched at depth $\frac{h}{2}$ and $\frac{3h}{2}$ from the surface of lighter liquid. If V_1 and V_2 are the velocities of a flux at these two holes, then V_1/V_2 is :



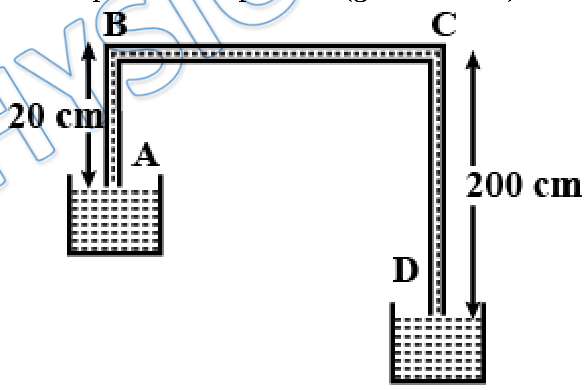
(a) $\frac{1}{2\sqrt{2}}$ (b) $\frac{1}{2}$
(c) $\frac{1}{4}$ (d) $\frac{1}{\sqrt{2}}$

Q 16. A siphon in use is demonstrated in the following figure. The density of the liquid flowing in siphon is 1.5 gm/cc. The pressure difference between the point P and S will be



(a) $10^5\ N/m$ (b) $2 \times 10^5\ N/m$
(c) zero (d) infinity

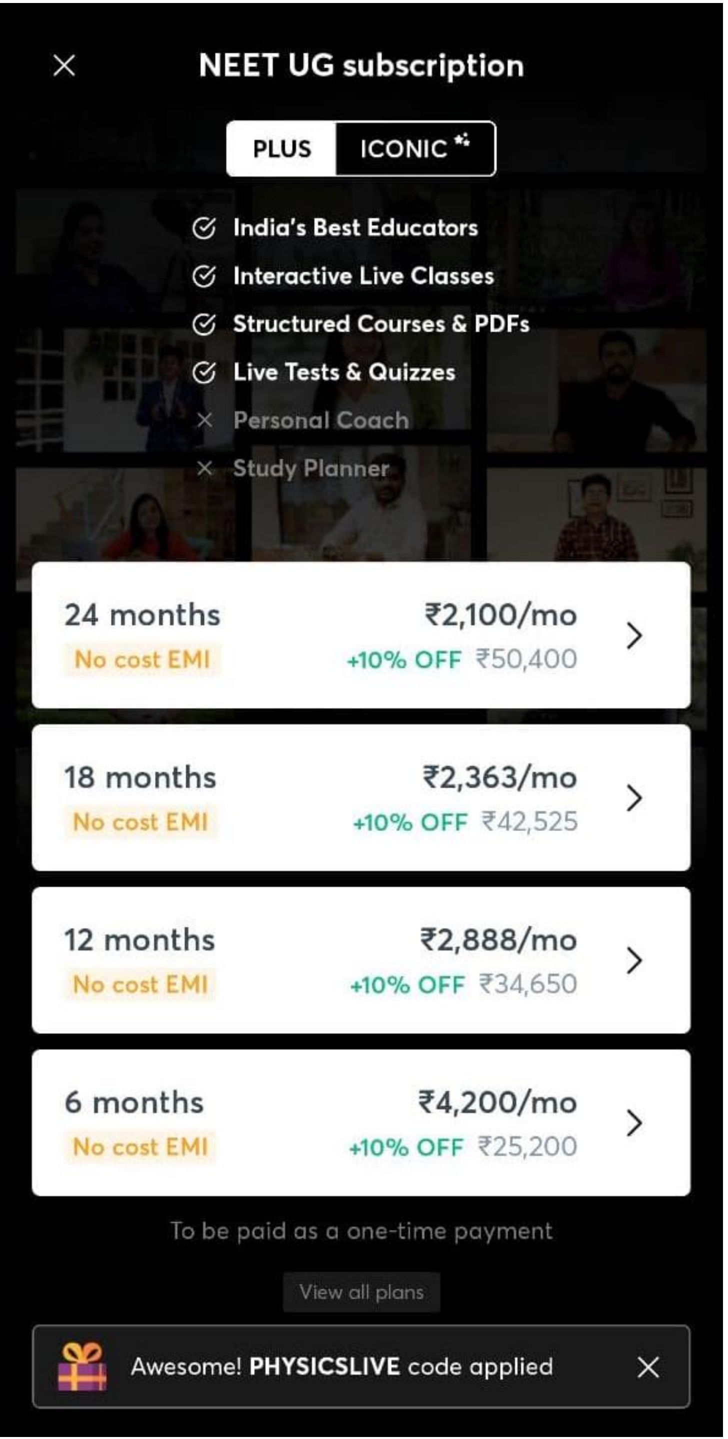
Q 17. The figure shows a siphon in action. Cross sectional area of pipe is 1sq.cm. and atmospheric pressure is 100000 Pa. The liquid flowing through the siphon has a density of 1 g/cc. Calculate the pressure at point B (g = 10 m/s^2)



(a) 0.7atm (b) 0.8atm
(c) 0.9atm (d) 0.6 atm

Answer Key

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



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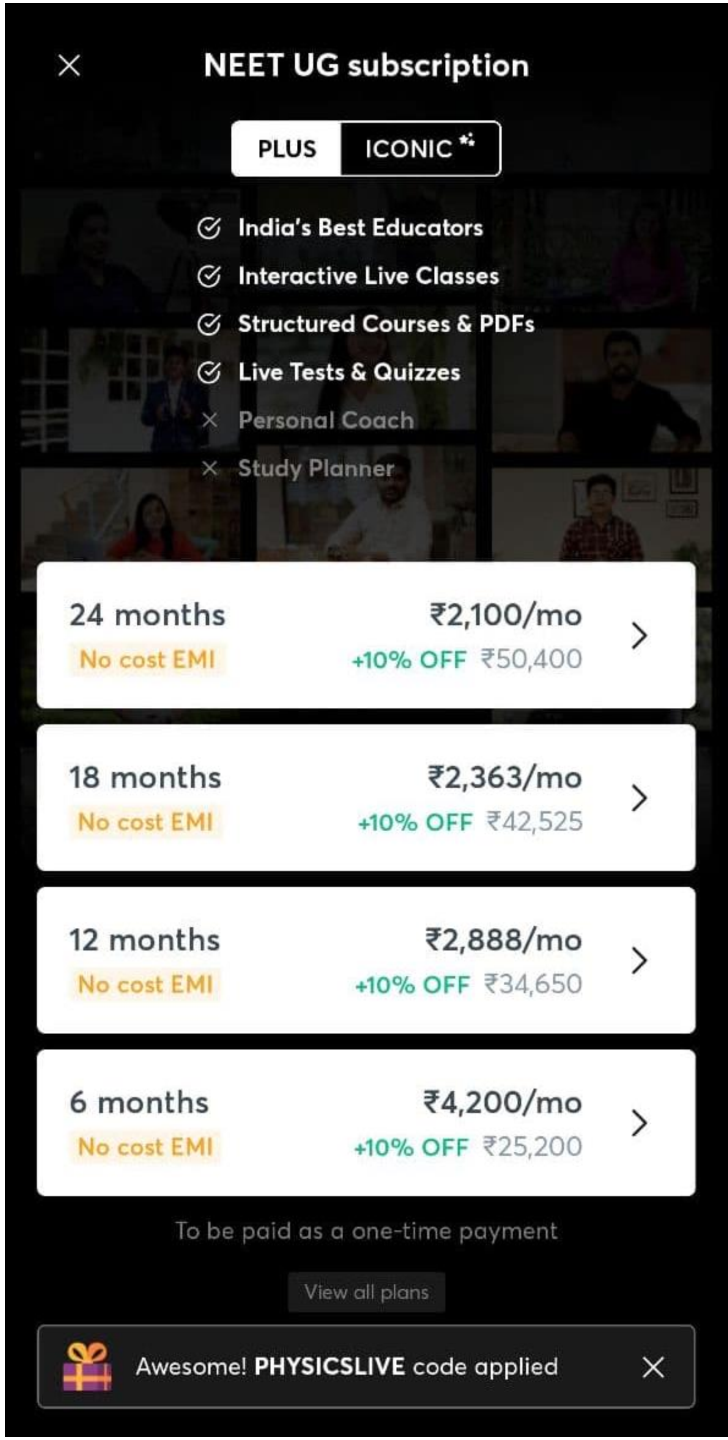

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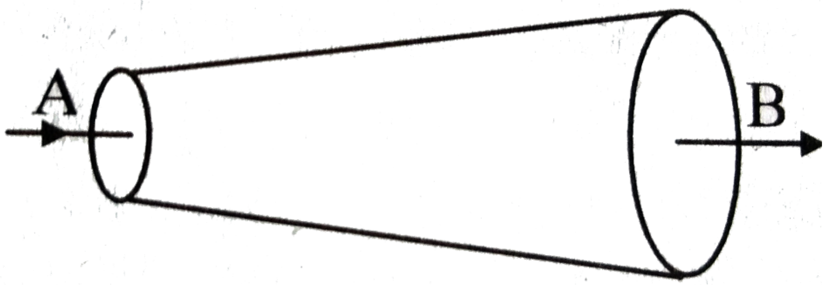
Written Solution

DPP-3 Fluid: Equation of Continuity, Bernoulli's Theorem and its applications

By Physicsaholics Team

Solution: 1



$$Q_A = Q_B$$

$$a_A V_A = a_B V_B$$

$$\frac{V_A}{V_B} = \frac{a_B}{a_A}$$

$$\frac{V_A}{V_B} = \frac{\pi (r_B)^2}{\pi (r_A)^2}$$

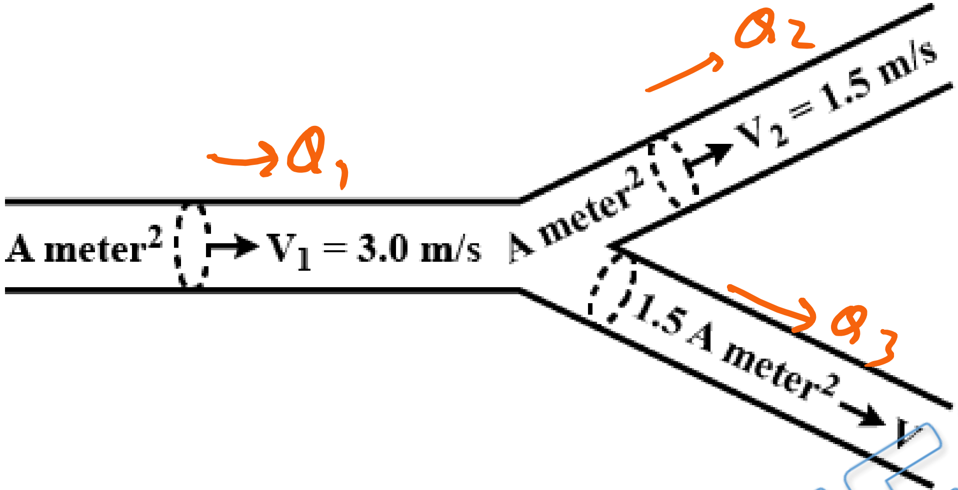
$$\frac{V_A}{V_B} = \left(\frac{16}{8}\right)^2$$

$$\frac{V_A}{V_B} = \left(\frac{2}{1}\right)^2$$

$$\boxed{\frac{V_A}{V_B} = \frac{4}{1}}$$ Ans.

Ans. a

Solution: 2



$Q_1 = Q_2 + Q_3$

$A_1 V_1 = A_2 V_2 + A_3 V_3$

$A(3) = A(1.5) + 1.5A(v)$

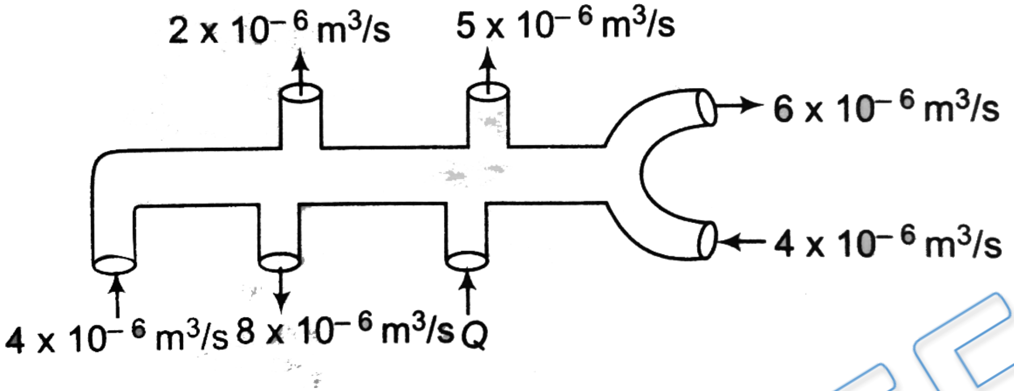
$3A = 1.5A + 1.5Av$

$1.5v = 3 - 1.5 = 1.5$

$v = \frac{1.5}{1.5} \Rightarrow \boxed{v = 1\ m/s}$ Ans.

Ans. c

Solution: 3



Total amount of water entering the pipe per second = Total amount of water leaving the pipe per second

$4\times10^{-6} + 4\times10^{-6} + Q = 2\times10^{-6} + 5\times10^{-6} + 6\times10^{-6} + 8\times10^{-6}$

$8\times10^{-6} + Q = 21\times10^{-6}\ m^3/s$

$Q = 13\times10^{-6}\ m^3/s$ Ans.

Ans. c

Solution: 4

$Q = \text{constant}$

$A_1 V_1 = A_2 V_2$

$(4.20\,cm^2) \times 5.18 = (7.60\,cm^2) \times V_2$

$V_2 = \frac{4.20 \times 5.18}{7.60}$

$V_2 = 2.86\ m/s$ Ans.

Ans. d

Solution: 5

$A_1 v_1 = A_2 v_2$

$4 \times 10^{-4} \times 2 = 2 \times 10^{-4} \times v_2$

$\boxed{v_2 = 4 \text{ m/s}}$

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

$3 \times 10^5 + (1000)(10)(0) + \frac{1}{2}(1000)(2)^2 = P_2 + (1000)(10)(8) + \frac{1}{2}(1000)(4)^2$

$3 \times 10^5 + 0 + 2 \times 10^3 = P_2 + 8 \times 10^4 + 8 \times 10^3$

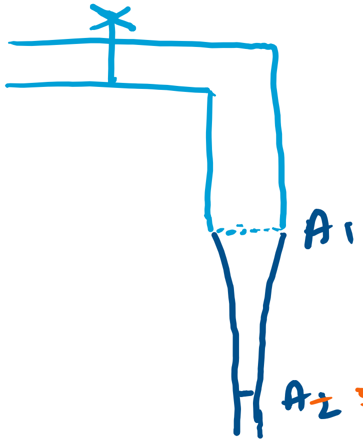
$\Rightarrow$

$P_2 = 2.14 \times 10^3 \text{ N/m}^2$

$\boxed{P_2 = 2.14 \times 10^5 \text{ N/m}^2}$ Ans.

Ans. a

Solution: 6



$$P_1 + (1000 \times 10 \times 0.15) + \frac{1}{2}(1000)(1)^2 = P_2 + (1000 \times 10 \times 0) + \frac{1}{2}(1000) \times (v_2)^2$$

$\because P_1 = P_2 =$ atmospheric pressure

$$\Rightarrow 1500 + 500 = 0 + 500 v_2^2$$

$$2000 = 500 v_2^2$$

$$v_2^2 = 4$$

$$\boxed{v_2 = 2\ m/s}$$

$$A_1 v_1 = A_2 v_2$$

$$10^{-4} \times 1 = A_2 v_2$$

$$A_2 v_2 = 10^{-4} \quad (1)$$

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

$$A_2 v_2 = 10^{-4}$$

$$A_2 \times 2 = 10^{-4}$$

$$A_2 = \frac{1}{2} \times 10^{-4}\ m^2$$

$$\boxed{A_2 = 5 \times 10^{-5}\ m^2} \text{ Ans.}$$

Ans. a

Solution: 7

$h = \text{constant}$

$A_1 = 10\ cm^2$

$v_1 = 1\ m/s$

$P_1 = 2000\ Pa$

$P_2 = ?$

$A_2 = 5\ cm^2$

$A_1 V_1 = A_2 V_2$

$(10\ cm^2) \times (1) = (5\ cm^2) \times (V_2)$

$\boxed{V_2 = 2\ m/s}$

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

$2000 + \rho g h + \frac{1}{2}(1000)(1)^2 = P_2 + \rho g h + \frac{1}{2}(1000)(2)^2$

$P_2 = 2000 + 500 - 2000$

$\boxed{P_2 = 500\ Pa}$ Ans

Ans. c

Solution: 8

$A_1 V_1 = A_2 V_2$

$0.02 \times 2 = (0.01) V_2$

$V_2 = 4 \text{ m/s}$

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

$h = \text{same.}$

$P + \frac{1}{2}\rho v^2 = \text{Constant}$

$4 \times 10^4 + \frac{1}{2}(1000)(2)^2 = P_2 + \frac{1}{2}(1000)(4)^2$

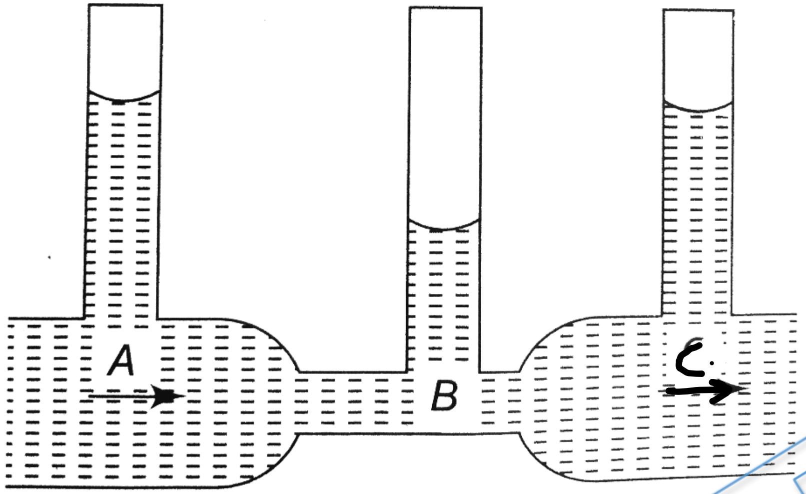
$P_2 = 40{,}000 + 2000 - 8000$

$P_2 = 34000 \text{ Pa}$

$P_2 = 3.4 \times 10^4 \text{ Pa}$ Ans.

Ans. c

Solution: 9



Area = a

$a_A = a_C > a_B$

$\Rightarrow v_A = v_C < v_B$

so; $\Rightarrow P_A = P_C > P_B$

$\Rightarrow$ means liquid height at point B will be minimum & at A & C will be equal.

$\because h =$ same

so; $P + \frac{1}{2}\rho v^2 =$ constant

if $v\uparrow \Rightarrow P\downarrow$

& $Av =$ constant

if $A\downarrow \Rightarrow v\uparrow$

Ans. d

Solution: 10

$P_1 = 3.5 \times 10^5 \ N/m^2$

$P_2 = 3 \times 10^5 \ N/m^2$

[initially, when valve is closed]

$v_1 = 0$

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

$(3.5 \times 10^5) + \rho g h + \frac{1}{2}(1000) \times (0)^2 = 3 \times 10^5 + \rho g h + \frac{1}{2}(1000)\, v_2^2$

$0.5 \times 10^5 = 500\, v_2^2$

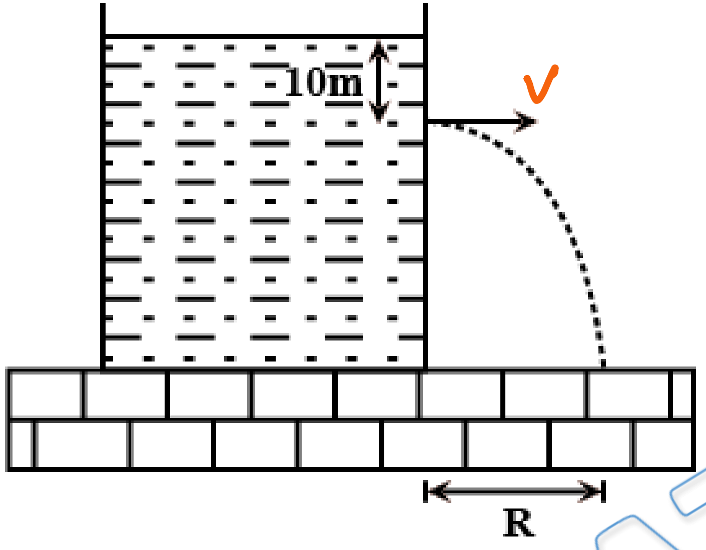
$50000 = 500\, v_2^2$

$v_2^2 = 100$

$\boxed{v_2 = 10 \ m/s}$ Ans.

Ans. b

Solution: 11



$\rho = 10^3\ kg/m^3$ $h = 10\ cm$

$v = \sqrt{2gh}$ — ①

$v = \sqrt{2 \times 10 \times (10 \times 10^{-2})}$

$v = \sqrt{2}\ m/s$

$R = vt$

for making Range double

$v' = 2v$

$\Rightarrow 2v = \sqrt{2gh_2}$ — ②

$\frac{①}{②} \Rightarrow \frac{1}{2} = \sqrt{\frac{h}{h_2}} \Rightarrow h_2 = 4h$

so, $h = 10\ m$

so, h_2 should be $4h = 40\ m$

so, $\Delta h = 40 - 10 = 30\ m$

so, extra pressure required $= \rho g h$

$= 10^3 \times 10 \times (30) = 3 \times 10^5\ N/m^2$

$\Delta P = 3\ atm$ Ans.

Ans. d

Solution: 12

$P = 3\,atm = 3\times10^5\ N/m^2$

$P_0 =$ pr. at surface $= 10^5\ N/m^2$

difference in pr at upper & bottom surfaces $= 3\times10^5 - 10^5 = 2\times10^5\ N/m^2$

$\rho g h = 2\times10^5$

$1000\times10\,h = 2\times10^5$

$h = 20\,m$

$v = \sqrt{2gh}$

$v = \sqrt{2\times10\times20}$

$v = \sqrt{400}\ m/s$ Ans.

Ans. a

Solution: 13

time required to empty tank

$$t = \frac{a}{A}\sqrt{\frac{2h}{g}}$$

Let crosssection of vessel $= A_0$

then $t_1 = \frac{A_0}{A}\sqrt{\frac{2h}{g}} = t$ —— (1)

$$t_2 = \frac{A_0}{A}\sqrt{\frac{2(4h)}{g}} \quad \text{—— (2)}$$

$\frac{(1)}{(2)} \Rightarrow \frac{t}{t_2} = \sqrt{\frac{h}{4h}}$

$\boxed{t_2 = 2t}$ Ans.

Ans. c

Solution: 14

$H = 0.4\,m$

$d_1 = 0.16\,m$; $r_1 = 0.08\,m$

$h = 0.16\,m$ [Height of water column]

$r_2 = 5 \times 10^{-3}\,m$

$A = \pi r_1^2 = \pi (0.08)^2$

$a = \pi r_2^2 = \pi (5 \times 10^{-3})^2$

$$t = \frac{A}{a}\sqrt{\frac{2h}{g}}$$

$$t = \frac{\pi (0.08)^2}{\pi (5 \times 10^{-3})^2} \times \sqrt{\frac{2 \times 0.16}{9.8}}$$

$$t = \frac{64 \times 10^{-4}}{25 \times 10^{-6}} \times \sqrt{\frac{0.32}{9.8}}$$

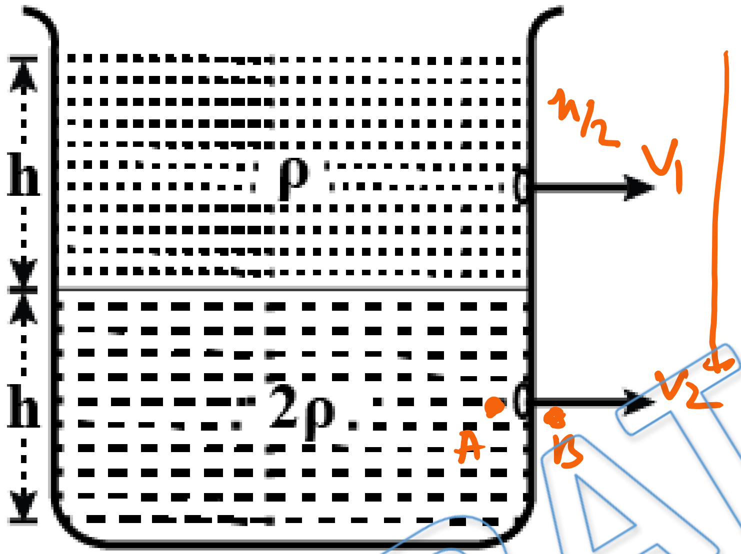
$$t = \frac{64}{25} \times 10^2 \sqrt{\frac{0.32}{9.8}}$$

$$t = 0.463 \times 10^2$$

$$\boxed{t = 46.3\ \text{sec}}$$ Ans.

Ans. b

Solution: 15



$v = \sqrt{2gH}$

$v_1 = \sqrt{2g\, h/2} = \sqrt{gh}$

$v_2 = \sqrt{2gh}$

$$\boxed{\frac{v_1}{v_2} = \frac{1}{\sqrt{2}}}$$

for $v_2 = ?$

$A \to B$

$\left(P + \rho g h + \frac{1}{2}\rho v^2\right)_A = \left(P + \rho g h + \frac{1}{2}\rho v^2\right)_B$

$[\because h_A = h_B]$ & $v_A \to 0$

$\left(P_0 + \rho g h + 2\rho g \frac{h}{2}\right) + 0 + 0 = P_0 + \frac{1}{2}(2\rho) v_2^2$

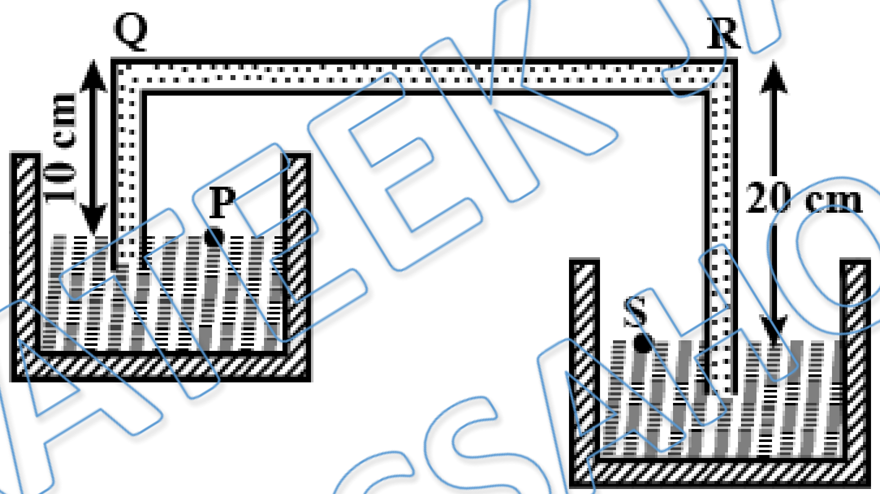
$2\rho g h = \rho v_2^2$

$$\boxed{v_2 = \sqrt{2gh}}$$ Ans

Ans. d

Solution: 16

As the both points are at the surface of liquid and these points are in the open atmosphere. So both point possess similar pressure and equal to 1 atm. Hence the pressure difference will be zero.



Ans. c

Solution: 17

flow velocity in pipe $= \sqrt{2gh} = \sqrt{\frac{2 \times 10(200-20)}{100}} = 6\ m/sec$

Using Bernoulli theorem →

$P_0 = P_B + \frac{1}{2}\rho v^2 + \rho g h$

Atmospheric pressure (P_0)

$P_0 = P_B + \frac{1}{2} \times 10^3 \times 36 + 10^3 \times 10 \times \frac{20}{100}$

$P_0 = P_B + 20 \times 10^3 = P_B + \frac{20 \times 10^3}{10^5} P_0$

$\Rightarrow P_B = (1 - .2) P_0 = .8 P_0 = .8\ atm$

Ans. b

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