

Mechanical Properties of Fluids

Self-Assessment

Module 1 Pressure

Q.10.1.1. A vessel is filled with a liquid of density d up to a height h . The pressure exerted on the bottom of the vessel will be the maximum when the vessel is

- (A) on the surface of the earth
- (B) on top of a hill.
- (C) deep inside a mine
- (D) on the surface of the moon

Q.10.1.2. Two vessels A and B filled with water and glycerine respectively up to a height h exert pressures P_a and P_b at their respective bottoms. Then

- (A) $P_a = P_b$
- (B) $P_a > P_b$
- (C) $P_a < P_b$
- (D) the values of P_a and P_b will depend on the cross section of the containers.

Q.10.1.3. A pan (assumed massless) filled with sand is placed on a weighing scale calibrated to read zero.

Fig.Q.10.1.1 Marbles, each of mass m , are falling into the pan of unit area at the rate of n per second. The marbles hit the pan with a speed u and stick to the sand without bouncing. At time t second, the pressure exerted at the bottom of the pan is

- (A) mu
- (B) num
- (C) $nmu + n.mtg$
- (D) $nmut + n.mg$

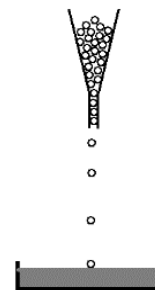


Fig.Q.10.1.1

Q.10.1.4 Which of the following is SI unit of pressure?

- (A) Nm^{-2} only
- (B) Jm^{-3} only

- (C) $\text{kg m}^{-1}\text{s}^{-2}$ only
 (D) All of the above.

Q.10.1.5 The Fig.Q.10.1.2 shows four points A, B, C and D at different heights from the surface of the earth. P_A , P_B , P_C and P_D denote the atmospheric pressures at the points A, B, C and D respectively. Given $P_A - P_B = P_B - P_C = P_C - P_D$

Which of the following statements is true?

- (A) $h_1 > h_2 > h_3$
 (B) $h_1 < h_2 < h_3$
 (C) $h_1 = h_2 = h_3$
 (D) $h_1 = h_2 > h_3$.

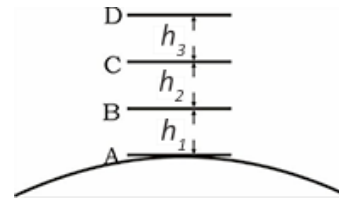


Fig.Q.10.1.2

Q.10.1.6 A, B, C and D are points on the same vertical line near the surface of earth, separated by distances h_1 , h_2 and h_3 as shown in Fig.Q.10.1.3. Assume that the density of air remains constant over the points and $P_A - P_B = P_B - P_C = P_C - P_D$.

The correct statement out of the following is

- (A) $h_1 > h_2 > h_3$
 (B) $h_1 < h_2 < h_3$
 (C) $h_1 = h_2 = h_3$
 (D) $h_1 = h_2 > h_3$.

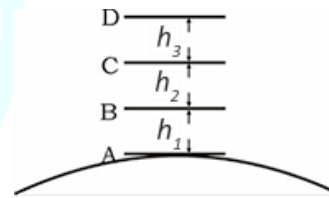


Fig.Q.10.1.3

Q.10.1.7 The atmospheric pressure has the maximum value

- (A) inside a deep well.
 (B) on the surface of the earth.
 (C) 100 km above the surface of the earth.
 (D) at a point just above the atmosphere.

Q.10.1.8 The Fig. 10.1.4 shows two vessels A and B with varying cross sectional areas. The vessels are filled with water to the same heights. P_A and P_B denote the pressures exerted by water at the bottoms of the vessels. F_A and F_B are the corresponding thrusts. We have

- (A) $F_A = F_B; P_A = P_B$
 (B) $F_A > F_B; P_A = P_B$
 (C) $F_A < F_B; P_A > P_B$
 (D) $F_A < F_B; P_A = P_B$

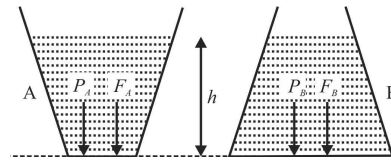


Fig.Q.10.1.4

Q.10.1.9. A tank with a square base is divided by a vertical partition in the middle (Fig.Q.10.1.5). The bottom of the partition has a small hinged door. The two parts of the tank are filled to the same height with different liquids of densities ρ_1 and ρ_2 as shown. Given that $\rho_1 > \rho_2$.

The door experiences

- (A) a net force directed towards the right.
 (B) a net force directed towards the left
 (C) no net force
 (D) a net force along the vertical.

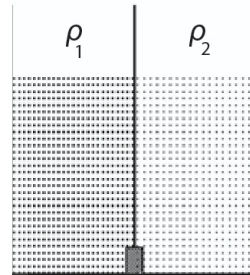


Fig.Q.10.1.5

Q.10.1.10. A manometer reads the pressure of a gas in an enclosure as shown in Fig.Q.10.1.6 (a). When the pump removes some of the gas, the manometer reads as in Fig.Q.10.1.6 (b). The change in pressure in the enclosure expressed in terms of the length of the liquid column is

- (A) 2 cm
 (B) 38 cm
 (C) 40 cm
 (D) 36 cm

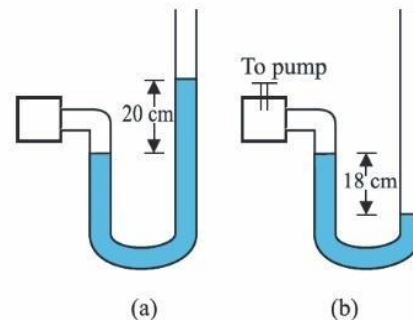


Fig.Q.10.1.6 (a),(b)

Module 2 Bernoulli's Principle

Q10.2.1. The streamlines indicating the flow of an ideal liquid are closely packed in a region. This indicates

- (A) an increase in velocity
- (B) a decrease in velocity
- (C) an increase in density
- (D) a decrease in density

Q10.2.2. A horizontal tube of varying cross-section has a streamlined flow of an ideal liquid. R and $2R$ are the radii of the tube at points P and Q respectively. V_P and V_Q are the speeds of flow of the liquid at P and Q. We have

- (A) $V_P = 2V_Q$
- (B) $2V_P = V_Q$
- (C) $V_P = 4V_Q$
- (D) $4V_P = V_Q$

Q.10.2.3. A liquid of density d flows in a tube of radius r . The flow tends to be turbulent if

- (A) d decreases, r increases.
- (B) d decreases, r decreases
- (C) d increases and r increases
- (D) d increases and r decreases

Q.10.2.4 Which of the following laws leads to the equation of continuity in fluid flow?

- (A) Newton's second law
- (B) law of conservation of energy
- (C) law of conservation of mass
- (D) law of conservation of linear momentum

Q.10.2.5 A horizontal cylindrical tube of radius R open at one end has a plate having N holes each of radius r fixed at the other end. A liquid in streamlined flow enters the open end of the tube with speed v . The speed of liquid emerging out of each hole at the other end is

- (A) Rv/Nr
- (B) NRv/r .
- (C) R^2v/Nr^2

(D) NR^2v/r^2

Q.10.2.6 A thin horizontal plate of area a and mass M is in equilibrium in the gravity of earth without any support due to air(density d) flowing with speed v and nv below and above the plates. The value of M

- (A) $(n-1) av^2d/2g$
- (B) $(n^2-1) av^2d/2g$
- (C) $(n^2-1) av^2d/g$
- (D) $(n^2+1) av^2d/2g$

Q.10.2.7. During storms, the thatched roofs sometime get blown off because

- (A) pressure outside is greater than the pressure inside the room.
- (B) pressure inside is greater than the pressure outside the room.
- (C) of low speed and low pressure inside.
- (D) of high speed and high pressure inside.

Q.10.2.8 Fig.Q.10.2.1 (a), (b), (c), and (d) refer to the steady flow of a non-viscous liquid. The correct Figs. are

- (A) (a) and (d)
- (B) (b) and (d)
- (C) (a) and (c)
- (D) (b) and (c)

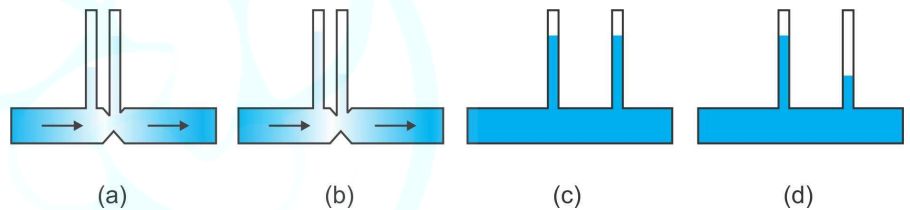


Fig.Q.10.2.1 (a),(b),(c),(d)

Q.10.2.9 The cylindrical tube of a spray pump has a cross-section of 8.0 cm^2 . One end of the tube has a number of identical fine holes each of area 1.0 mm^2 . The liquid flows inside the tube at 15 cm/s and emerges out of each hole at 60 cm/s . The number of the holes is

- (A) 400
- (B) 200
- (C) 100
- (D) 50

Q.10.2.10 A non-viscous, incompressible fluid is in streamlined flow through a narrow pipe of varying cross-section. The pipe is horizontal and its cross section decreases uniformly as shown in Fig.Q.10.2.2. If v_1 , v_2 denote the speeds of the fluid at the two ends and P_1 , P_2 the respective values of pressure, then

- (A) $P_1 > P_2$; $v_1 > v_2$
- (B) $P_1 < P_2$; $v_1 < v_2$
- (C) $P_1 > P_2$; $v_1 < v_2$
- (D) $P_1 = P_2$; $v_1 = v_2$

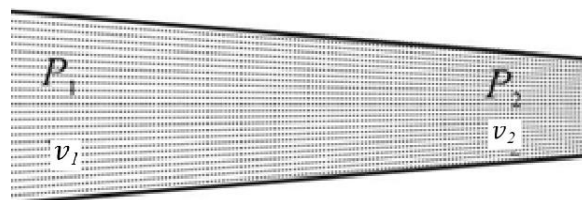


Fig.Q.10.2.2

Module 3 Surface Tension

Q.10.3.1. The angle of contact with glass for ethyl alcohol, water, methyl iodide and mercury is 0° , 8° , 30° and 140° . Four identical glass capillaries are immersed in the above liquids. The liquid surface seen in the capillary is convex in case of

- (A) ethyl alcohol
- (B) water
- (C) methyl iodide
- (D) mercury

Q.10.3.2 The surface of a liquid stored in a glass container is concave. The angle of contact for the liquid - glass is θ . We have

- (A) $F_{\text{Cohesion}} > F_{\text{Adhesion}}$ and $\theta > 90^\circ$
- (B) $F_{\text{Cohesion}} < F_{\text{Adhesion}}$ and $\theta < 90^\circ$
- (C) $F_{\text{Cohesion}} > F_{\text{Adhesion}}$ and $\theta < 90^\circ$
- (D) $F_{\text{Cohesion}} < F_{\text{Adhesion}}$ and $\theta > 90^\circ$

Q.10.3.3 The surface tension is correctly represented by the relation

- (A) Force/area
- (B) Energy/area

- (C) Force/length
- (D) Energy/length

Q.10.3.4 Two mercury droplets of radii 0.1 cm and 0.2 cm coalesce into one single drop. The surface tension of mercury is $435.5 \times 10^{-3} \text{ Nm}^{-1}$. The amount of energy released is

- (A) $-3.7 \times 10^{-7} \text{ J}$
- (B) $3.7 \times 10^{-6} \text{ J}$
- (C) $7.4 \times 10^{-6} \text{ J}$
- (D) $3.7 \times 10^{-2} \text{ J}$

Q.10.3.5 A square frame of side L is dipped in a liquid of surface tension S . On taking the frame out, a liquid membrane is formed. The force acting on the frame is

- (A) $2 SL$
- (B) $4 SL$
- (C) $8 SL$
- (D) $10 SL$

Q.10.3.6 The work done in increasing the size of a soap film from $10 \text{ cm} \times 6 \text{ cm}$ to $10 \text{ cm} \times 11 \text{ cm}$ is $2 \times 10^{-4} \text{ J}$. The surface tension of the soap solution is

- (A) $2 \times 10^{-2} \text{ Nm}^{-1}$
- (B) $2 \times 10^{-6} \text{ Nm}^{-1}$
- (C) $2 \times 10^{-4} \text{ Nm}^{-1}$
- (D) $4 \times 10^{-2} \text{ Nm}^{-1}$

Q.10.3.7 Two capillary tubes A and B with radii in the ratio 1:2 are immersed in a liquid. A mass M of the liquid rises in tube A. The mass of the liquid that will rise in tube B is

- (A) $4M$
- (B) $2M$
- (C) M
- (D) $\frac{M}{2}$

Q.10.3.8 Capillaries of radii 0.2 cm and 0.3 cm are dipped in liquids of surface tensions 40 N/m and 50 N/m respectively. h_1 and h_2 are the heights to which liquids rise in the two capillaries. Taking the angle of contact in the two cases to be the same, h_1/h_2 is

- (A) 8/15
- (B) 6/5
- (C) 5/6
- (D) 15/8

Q.10.3.9 The variation of the height h to which a given liquid rises in a capillary of radius r is correctly represented by the graph shown in Fig.Q.10.3.1 (a),(b),(c) and (d)

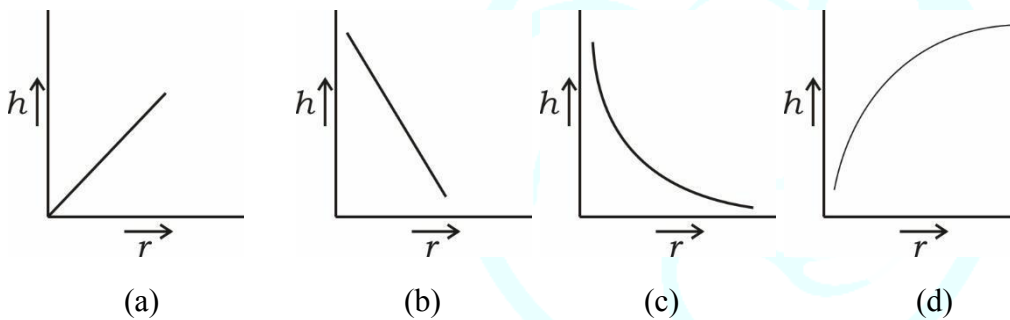


Fig.Q.10.3.1 (a),(b),(c) and (d)

- (A) (a)
- (B) (b)
- (C) (c)
- (D) (d)

Q.10.3.10 A liquid of surface tension S rises to a height h_E in a glass capillary tube of radius r on earth. The same liquid in another glass capillary of radius $3r$ rises to a height h_M on the moon. The ratio h_M/h_E is

- (A) 2
- (B) 1/2
- (C) 4
- (D) 1/4



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