DAILY PRACTICE PROBLEM

Density DPP-01

1. Two liquids having densities d_1 and d_2 are mixed in such a way that both have same mass. The density of the mixture is –

(1) $\frac{d_1+d_2}{2}$ (2) $\frac{d_1+d_2}{d_1 d_2}$ (3) $\frac{d_1 d_2}{d_1+d_2}$ (4) $\frac{2d_1 d_2}{d_1+d_2}$

2. If 2 kg of substance of relative density 4 and 3 kg of another substance of relative density 5 are mixed together then relative density of mixture is–

(1) $\frac{50}{11}$ (2) $\frac{25}{11}$ (3) 50 (4) $\frac{35}{11}$

3. If 1 gram of substance of relative density 2 and 4 gram of another substance of relative density 3 are mixed together, then the relative density of the mixture is–

(1) 2.4 (2) 2.5 (3) 2.7 (4) 2.9

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

(1) the density of a liquid is smaller than that of a solid
(2) the forces between the molecules is stronger in solid than in liquids
(3) the atoms combine to form bigger molecules in a solid
(4) the average separation between the molecules is larger in solids

5. Two liquids of relative densities in ratio 3 : 4 are mixed in volume ratio 1 : 2 find ratio of their masses -

(1) 3 : 4 (2) 3 : 8 (3) 8 : 3 (4) 4 : 3

Answer Key

Question	1	2	3	4	5
Answer	4	1	3	2	2

SOLUTIONS

1. (4)

$$\rho = \frac{m_1+m_2}{v_1+v_2} = \frac{m+m}{\frac{m}{d_1}+\frac{m}{d_2}} = \frac{2d_1 d_2}{d_1+d_2}$$

2. (1)

$$\frac{M}{V} = \frac{m_1+m_2}{\frac{m_1}{d_1}+\frac{m_1}{d_2}} = \frac{5}{\frac{2}{4}+\frac{3}{5}} = \frac{50}{11}$$

3. (3)

$$R.D = \frac{m_1+m_2}{\frac{m_1}{d_1}+\frac{m_2}{d_2}} = \frac{1+4}{\frac{1}{2}+\frac{4}{3}} = \frac{30}{11} \approx 2.7$$

4. (2)

5. (2)

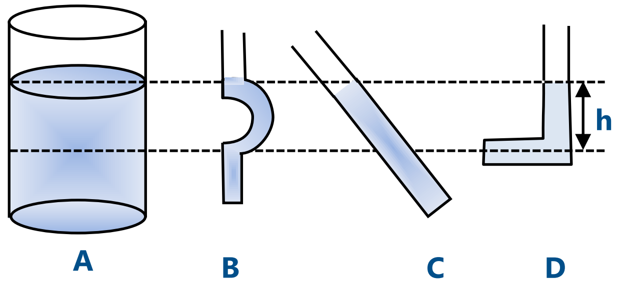
$\rho_1 : \rho_2 = 3:4$

$V_1 : V_2 = 1:2$

$M_1 : M_2 = \rho_1 V_1 : \rho_2 V_2$ = 3 × 1 : 4 × 2 = 3 : 8

Problems based on Pressure due to Liquid Column and Barometer DPP-02

1. **Figure shows four containers of olive oil. The pressure at depth h is**

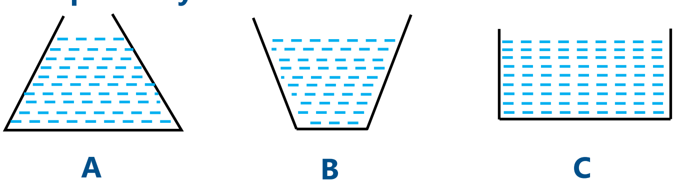


(1) Least in B and C both
(2) greatest in A
(3) greatest D
(4) equal in all the containers

2. **A cylindrical vessel containing a liquid is closed by a smooth piston of mass m. If A is the cross-sectional area of the piston and P_0 is the atmospheric pressure, then the pressure of the liquid just below the piston is**

(1) P_0
(2) $P_0 + \frac{mg}{A}$
(3) $\frac{mg}{A}$
(4) Data is not sufficient.

3. **Three vessels A, B and C of different shapes contain water upto the same height as shown in the figure. P_A, P_B and P_C be the pressures exerted by the water at the bottom of the vessels A, B and C respectively. Then**



(1) $P_A > P_B > P_C$
(2) $P_B > P_C > P_A$
(3) $P_C > P_B > P_A$
(4) $P_A = P_B = P_C$

4. **The volume of an air bubble is doubled as it rises from the bottom of lake to its surface. The atmospheric pressure is 75 cm of mercury. The ratio of density of mercury to that of lake water is $\frac{40}{3}$. The depth of the lake is metre is–**

(1) 10
(2) 15
(3) 20
(4) 25

5. **A large vessel of height H, is filled with a liquid of density ρ, upto the brim. A small hole of radius r is made at the side vertical face close to the base. The horizontal force is required to stop the gushing of liquid is–**

(1) $(\rho g H)\pi r^2$ (2) $\rho g H$ (3) $\rho g H \pi r$ (4) $\rho g \pi r^2$

6. **A rectangular container with base 5 cm × 10 cm contains 5 kg of water. What is the pressure exerted by water at the bottom of the container–**

(1) 1 atm (2) 10^4 Pa (3) 490 N/m^2 (4) 9800 Pa

7. **Pressure at the bottom of a tank of water is 3P, where P is atmospheric pressure. If the water is drawn out till the level of water is lowered by one fifth, then the pressure at the bottom of the tank is :-**

(1) 2P (2) 13P/5 (3) 8P/5 (4) 4P/5

8. **The pressure at the bottom of a tank containing a liquid does not depend on–**

(1) Acceleration due to gravity (2) Height of the liquid column

(3) Area of the bottom surface (4) Density of the liquid

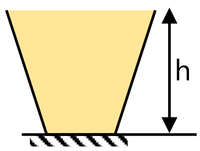
9. **The height of barometer filled with a liquid of density 3.4 g/cm^3 under normal condition is approximately equal to–**

(1) 1m (2) 3m (3) 4m (4) 5m

10. **Total pressure at depth d of water surface is found to be 2.5 atm. d is nearly equal to**

(1) 1.5m (2) 7.5m (3) 15m (4) 25m

11. **Mass M of a liquid of density ρ is filled in a light beaker and kept on a horizontal table as shown in the figure. The height of the liquid in the beaker is h. The beaker is wider on top than at its base and the cross-sectional area of the base is A. Neglect the effect of atmospheric pressure. Now, choose the correct statement from the following.**



(1) The pressure of liquid at the bottom surface is ρgh.

(2) The normal reaction exerted by the table on the beaker is ρghA.

(3) The pressure of the liquid at the bottom surface is $\frac{Mg}{A}$.

(4) The normal reaction exerted by the table on the beaker is 2Mg.

Answer Key

Question	1	2	3	4	5	6	7	8	9	10	11
Answer	4	2	4	1	1	2	2	3	2	3	1

SOLUTIONS

1. (4)

$P = h\rho g$

2. (2)

Since the piston is in equilibrium,

$\therefore$ $P_A = P_0A + mg$ or $P = P_0 + \frac{mg}{A}$

3. (4)

Pressure = $h\rho g$

Pressure at the bottom is independent of the area of the base of the vessel. It depends on the height of water upto which the vessel is filled with water. As in all the three vessels, levels of water are the same, therefore Pressure at the bottom in all the vessels is also same.

Hence, $P_A = P_B = P_C$

4. (1)

$P_1V_1 = P_2V_2$

$(P_0 + h\rho_w g)V = P_0(2V)$

$P_0 + h\rho_w g = 2P_0$

$h\rho_w g = P_0$

$hg = \frac{h.\rho_{Hg}.g}{\rho_w}$

$h = 75 \times \frac{40}{3} = 1000cm$

$= 10$ m

5. (1)

$F = \Delta PA = (H\rho g)\pi r^2$

6. (2)

$P = \frac{mg}{A} = \frac{5\times10}{5\times10\times10^{-4}} = 10^4 Pa$

7. **(2)**

$3P = P + h\rho_w g \Rightarrow h\rho_w g = 2P$

when water is drawn out, the pressure at bottom.

$$P' = P + \left(h - \frac{h}{5}\right)\rho_w g = P + \frac{4}{5}h\rho_w g$$

$$P' = P + \frac{4}{5}(2P) = \frac{13}{5}P$$

8. **(3)**

9. **(2)**

$h\rho g = h_{Hg}\rho_{Hg}g$

$$\Rightarrow h = h_{Hg} \times \frac{\rho_{Hg}}{\rho}$$

$=76\times\frac{13.6}{3.4}$ = 304 cm ≈ 3m

10. **(3)**

1atm ≈ 10m of water

Total pressure = 2.5atm

Gauge pressure = 1.5atm ≈ 15m of water

11. **(1)**

Pressure = ρgh (at bottom surface)

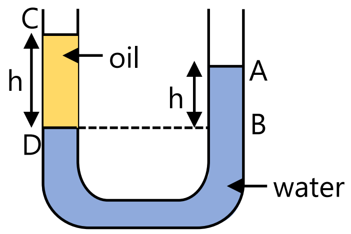
Normal reaction exerted by table on the beaker = Mg

U-tube DPP-03

1. A vertical U-tube of uniform cross-section contain (glycerin, relative density = 1.2) in both the arms. A 12cm water column is added to one of the limbs. The level difference between the two free surfaces in the two limbs will be–

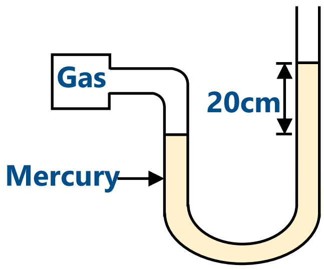
(1) 4 cm (2) 2 cm (3) 6 cm (4) 8 cm

2. In a U-tube experiment, a column AB of water is balanced by a column 'CD' of oil, as shown in the figure. Then the relative density of oil is:-



(1) $\frac{h_2}{h_1}$ (2) $\frac{h_1}{h_2}$ (3) $\frac{(h_1-h_2)}{h_1}$ (4) $\frac{h_2}{(h_1+h_2)}$

3. A manometer reads the pressure of a gas in an enclosure as shown in the figure: -



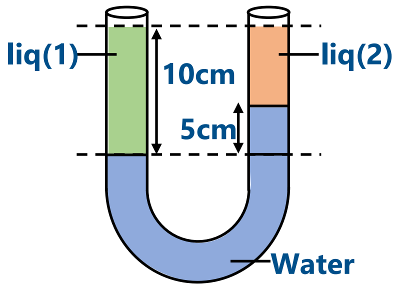
The absolute and gauge pressure of the gas in cm of mercury is (Take atmospheric pressure = 76cm of mercury)

(1) 76, 20 (2) 20, 76 (3) 96, 20 (4) 20, 96

4. An open U tube contains mercury. When 11.2 cm of water is poured into one of the arms of the tube, how high does the mercury rise in the other arm from its initial level

(1) 0.56 cm (2) 0.41 cm (3) 1.35 cm (4) 2.32 cm

5. **An open U-tube contains two unknown liquids separated by water as shown in figure. If density of a water is 1 gm/cc, density of liq (1) is 0.8 gm/cc then find density of liq. (2).**



(1) 0.8 cm (2) 0.7 cm (3) 0.9 cm (4) 0.6 cm

Answer Key

Question	1	2	3	4	5
Answer	2	1	3	2	4

SOLUTIONS

1. **(2)**

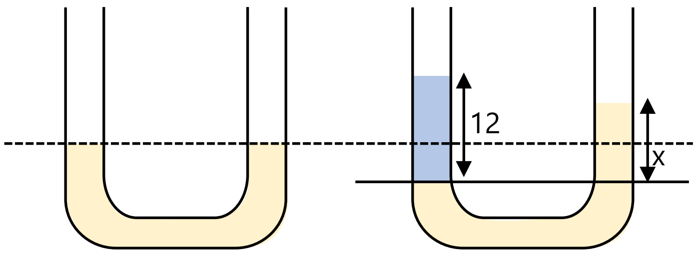
$P_0 + 12 \times 1 \times g = P_0 + x \times 1.2 \times g$

$x = 10$ cm

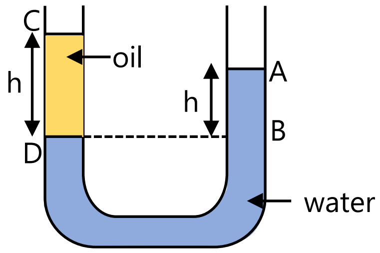
so difference of height

$= 12 - 10$

$= 2$ cm



2. **(1)**



$P_1 = P_2$

$P_o + \rho_{oil} \times g \times h_1 = P_o + \rho_w \times g \times h_2$

$\frac{\rho_{oil}}{\rho_w} = \frac{h_2}{h_1}$

3. **(3)**

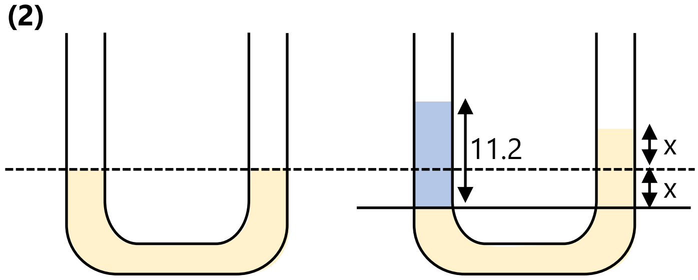
Here, atmospheric pressure P in figure = 76 cm of mercury

Pressure head, h = 20 cm of mercury

Absolute pressure = P + h = 76 + 20 = 96 cm of mercury

Gauge pressure = h = 20 cm of mercury

4. **(2)**



$\rho_w gh = \rho_{Hg} g(2x)$

$1 \times 11.2 = 13.6 \times 2x$

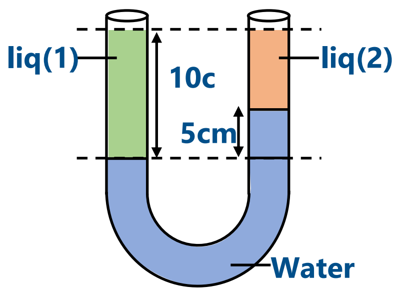
$x = 0.41$ cm

5. **(4)**

$h_1\rho_1 = h_2\rho_2 ++ h_w\rho_w$

$(10)(0.8) = (5)(\rho_2) + (5)(1)$

$\rho_2 = \frac{3}{5} \Rightarrow 0.6 \text{gm} / \text{cc}$



DAILY PRACTICE PROBLEM

Pascal's Law DPP-04

1. Air is blown through a hole a closed pipe containing liquid. Then the pressure will

(1) Increase on sides (2) Increase downwards
(3) Increase in all direction (4) Never increases

2. Hydraulic press is based on :

(1) Newton's law (2) Pascal's law
(3) Gravity law (4) Stoke's law

3. In a hydraulic lift, used at a service station the radius of the large and small piston are in the ratio of 20:1. What weight placed on the small piston will be sufficient to lift a car of mass 1500 kg?

(1) 3.75 kg (2) 37.5 kg (3) 7.5 kg (4) 5 kg

4. Pressure applied to an enclosed fluid is transmitted undiminished to every portion of the fluid and the walls of the containing vessel. This law was first formulated by

(1) Bernoulli (2) Archimedes (3) Boyle (4) Pascal

5. Hydraulic brakes work on the principle of

(1) Pascal's law (2) Thomson's law
(3) Newton's law (4) Brenoulli's theorem

6. In a hydraulic lift at a service station, the radii of the large and small pistons are in the ratio of 20 : 1. What weight placed on the small piston will be sufficient to lift a car of mass 1200 kg?

(1) 3 kgf (2) 30 kgf (3) 300 kgf (4) 3000 kgf

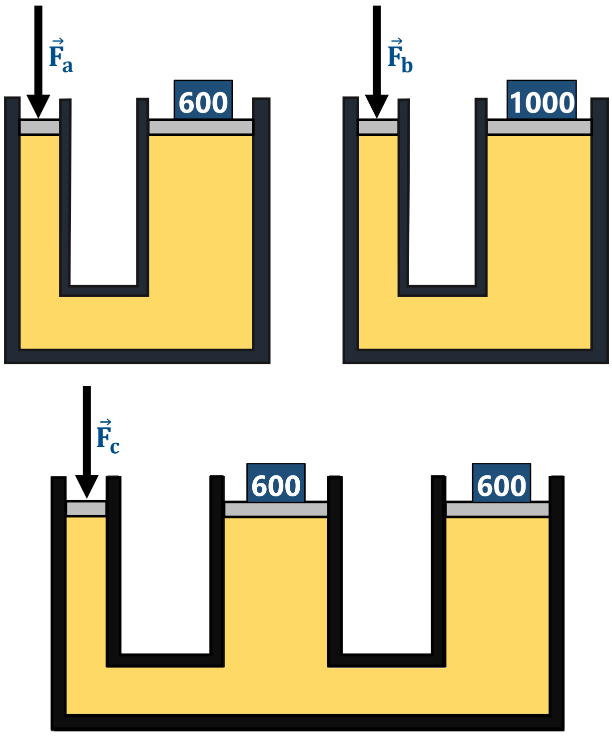
7. The diameter of the piston of a hydraulic automobile is D metre. What pressure, in atmosphere is required to lift a car of mass m kg?

(1) $\frac{4mg}{\pi D^2 \times 10^5}$ (2) $\frac{2mg}{\pi D^2}$ (3) $\frac{mg}{\pi D^2}$ (4) $10^5 \times \frac{4mg}{\pi D^2}$

8. **Two syringes of different cross section (without needle) filled with water are connected with a tightly fitted rubber tube filled with water. Diameters of the smaller piston and larger piston are 1 cm and 3 cm respectively. If a force of 10 N is applied to the smaller piston then the force exerted on the larger piston is :-**

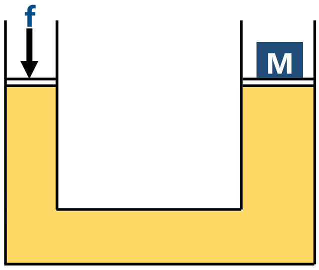
(1) 30 N (2) 60 N (3) 90 N (4) 100 N

9. **Rank in order, from largest to smallest, the magnitudes of the forces $\vec{F}_a$, $\vec{F}_b$ and $\vec{F}_c$ required to balance the masses. The masses (on same area) are in kilograms.**



(1) $F_a = F_b = F_c$ (2) $F_a > F_b = F_c$ (3) $F_b > F_a = F_c$ (4) $F_c > F_a > F_b$

10. **In hydraulic press radii of connecting pipes r_1 and r_2 are in ratio 1 : 2. In order to lift a heavy mass M on larger piston, the small piston must be pressed through a minimum force f equal to –**



(1) Mg (2) Mg/2 (3) Mg/4 (4) Mg/8

Answer Key

Question	1	2	3	4	5	6	7	8	9	10
Answer	3	2	1	4	1	1	1	3	3	3

SOLUTIONS

1. **(3)**

2. **(2)**

3. **(1)**

$\frac{m_1 g}{A_1} = \frac{m_2 g}{A_2}$

On solving $m_2 = 3.75\text{kg}$

4. **(4)**

5. **(1)**

6. **(1)**

Equating pressure,

$\frac{F}{\pi r^2} = \frac{m.g}{\pi R^2}$

$\frac{F}{\pi r^2} = \frac{1200.g}{\pi [20R]^2}$

$\Rightarrow F = 3$ kgf

7. **(1)**

$P \times \frac{\pi D^2}{4} = mg$ or $P = \frac{4mg}{\pi D^2}$ pascal

or $P = \frac{4mg}{\pi D^2 \times 10^5}$ atmosphere

8. **(3)**

Since pressure is transmitted undiminished throughout the water

$\therefore \frac{F_1}{A_1} = \frac{F_2}{A_2}$

where F_1 and F_2 are the forces on the smaller and on the larger pistons respectively and A_1 and A_2 are the respective areas.

$\therefore \quad F_2 = \frac{A_2}{A_1} F_1 = \frac{\pi (D_2/2)^2}{\pi (D_1/2)^2} F_1 = \left(\frac{D_2}{D_1}\right)^2 F_1 = \frac{(3\times 10^{-2}\text{m})^2}{(1\times 10^{-2}\text{m})^2} \times 10\text{N} = 90\text{N}$

9. **(3)**

$F_b > F_a = F_c$. The masses in c do not add. The pressure underneath each of the two large pistons is mg/A_2 and the pressure under the small piston must be the same.

10. **(3)**

According to Pascal's principle

$\frac{f_1}{f_2} = \frac{A_1}{A_2} = \frac{r_1^2}{r_2^2} = \frac{1}{4}$

$f_1 = \frac{1}{4}$ Mg

DAILY PRACTICE PROBLEM

Buoyancy, Archimedes' Principle and Laws of Floatation DPP-05

1. **A metallic sphere weighing 3 kg in air is held by a string so as to be completely immersed in a liquid of relative density 0.8. The relative density of metallic sphere is 10. The tension in the string is–**

(1) 18.7 N (2) 42.5 N (3) 32.7 N (4) 27.6 N

2. **A wooden cylinder floats vertically in water with half of its length immersed. The density of wood is:**

(1) Equal of that of water
(2) Half the density of water
(3) Double the density of water
(4) The question is incomplete

3. **A block of wood of mass 2 kg and density 5×10^3 kg/m^3 is suspended from a string. What will be the tension in the string if the block is completely immersed in water ? (g =10m/s^2)**

(1) 8N (2) 16N (3) 14N (4) 7N

4. **A block of aluminium of mass 1kg and volume 3.6×10^4m^3 is suspended from a string and then completely immersed in a container of water. Find out the decrease in tension in the string after immersion:**

(1) 3.6N (2) 3.2N (3) 4.8N (4) 1.6N

5. **Determine the resulting force using the Archimedes principle formula, if a steel ball of radius 6 cm is immersed in water. Assume the density of lead as 7900 kg/m^3**

(1) 6.86 N (2) 8.87 N (3) 4.78 N (4) 12.46 N

Answer Key

Question	1	2	3	4	5
Answer	4	2	2	1	2

SOLUTIONS

1. **(4)**

$$T = F_g - F_T = mg\left(1 - \frac{\rho}{d}\right) = 30\left(1 - \frac{0.8}{10}\right) = 27.6\,\text{N}$$

2. **(2)**

3. **(2)**

Tension in the string

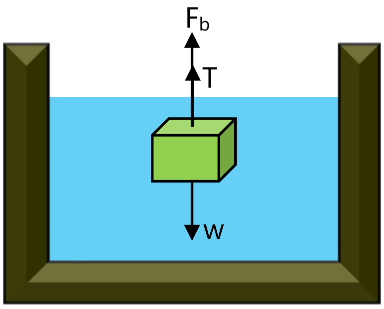
$T = W - F_b$

$= mg - \rho_w . V_{in}g$

$= mg - \rho_w\left(\frac{m}{\rho_b}\right)g$

$= mg\left(1 - \frac{\rho_w}{\rho_b}\right)$

$= 16$ N



4. **(1)**

Here, mass of the block, m = 1kg

Volume of the block, $V = 3.6 \times 10^{-4}$ m^3

Tension in the string, T = mg

When the block immersed completely in water, its weight becomes

$mg' = mg - F_b$

$= mg - V\rho_{water}g$

$\therefore$ Tension in the string, T' = mg'

$= mg - [mg - V\rho_{water}g] = V\rho_{water}g$

$= 3.6 \times 10^{-4} \times 10^3 \times 10$

$= 3.6$ N

5. **(2)**

Given parameter in the question

Radius of the steel Ball r = 0.06 m

Volume $V = \frac{4}{3}\pi r^3$

$V = \frac{4}{3}\pi(0.06)^3$

$V = 9.05 \times 10^{-4}$ m^3

Density of water $\rho = 1000$ kg/m^3, g = 9.8 m/s^2

$f_b = \rho gV$

$= 1000 \times 9.8 \times (9.05 \times 10^{-4})$

$= 8.87$ N

Problems based on Laws of Floatation DPP-06

1. **Ice piece are floating in a breaker A containing water and also in a beaker B containing miscible liquid of specific gravity 1.2. When ice melts, the level of–**

(1) Water increases in A
(2) Water decreases in A
(3) Liquid in B decreases
(4) Liquid in B increases

2. **A piece of wax weighs 18 g in air. A piece of metal to weighs 17 g in water. It is tied to the wax and both together weighs 25 g in water. Then the specific gravity of wax is–**

(1) 1 (2) 2.25 (3) 1.5 (4) 1.8

3. **The velocity of a small ball of mass M and density d_1 when dropped in a container filled with glycerine becomes constant after some time. If the density of glycerine is d_2, the viscous force acting on the ball is–**

(1) $Mg\left(1-\frac{d_2}{d_1}\right)$ (2) $Mg\frac{d_1}{d_2}$ (3) $Mg(d_1 - d_2)$ (4) $Mg\frac{d_2}{d_1}$

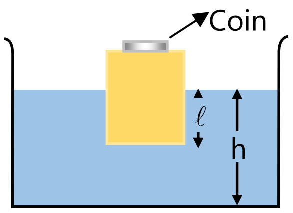
4. **A solid floats on the surface of water with $\left(\frac{1}{4}\right)^{th}$ of its volume outside the water. Its specific gravity is–**

(1) 4 (2) $\frac{4}{3}$ (3) $\frac{3}{4}$ (4) 2

5. **A piece of solid weighs 120 g in air, 80 g in water and 60 g in a liquid, then the relative density of solid and that of liquid are respectively–**

(1) 2 and 3 (2) 3 and 3/4 (3) 3 and 3/2 (4) 2 and 4/3

6. **A wooden block with a coin placed on its top floats in water as shown in figure. The ℓ and h are shown there. After some time the coin falls into the water then :-**



(1) ℓ decreases and h increases
(2) ℓ increases and h decreases
(3) Both ℓ & h increase
(4) Both ℓ & h decrease

7. **A certain block weight 15 N in air. It weight 12 N when immersed in water when immersed in another liquid it weighs 13 N, the relative density of the block is :-**

(1) 5 (2) 12 (3) 15 (4) None

8. **A boat carrying a number of large stones is floating in a water tank. What would happen to the water level if few stones are unloaded into water :-**

(1) Rises
(2) Falls
(3) Remains unchanged
(4) Rises till half the number of stones are unloaded and then beginning to fall

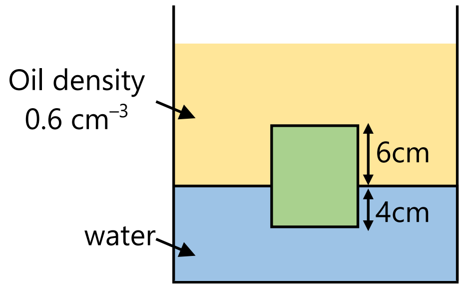
9. **A sample of metal weighs 210g in air and 180g in water. Density of metal is nearly equal to**

(1) 3×10^3 kgm^{-3} (2) 6×10^3 kgm^{-3} (3) 7×10^3 kgm^{-3} (4) 8×10^3 kgm^{-3}

10. **A piece of steel floats in mercury. The specific gravity of mercury and steel are 13.6 and 7.8 respectively. For covering the whole piece some water is filled above the mercury. What part of the piece is inside the mercury–**

(1) 0.54 (2) 0.50 (3) 0.47 (4) 0.62

11. **A cubical block of wood 10 cm on a side, floats at the interface of oil and water as shown in figure. The density of oil is 0.6 g cm^{-3} and density of water is 1 g cm^{-3}. The mass of the block is–**



(1) 706 g (2) 607 g (3) 760 g (4) 670 g

12. **A boy is carrying a bucket of water in one hand and a piece of plaster in the other. After transferring the plaster piece to the bucket (in which it floats) the boy will carry -**

(1) same load as before
(2) more load than before
(3) less load than before
(4) either less or more load, depending on the density of the plaster

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

(1) start oscillating
(2) sink to the bottom
(3) come back to the same position immediately
(4) come back to the same position slowly

14. **A ball whose density is 0.4 × 10^3 kg/m^3 falls into water from a height of 9 cm. To what depth does the ball sink?**

(1) 8 cm (2) 5 cm (3) 6 cm (4) 4 cm

Answer Key

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Answer	4	4	1	3	3	4	1	2	3	1	3	1	2	3

SOLUTIONS

1. **(4)**

2. **(4)**

Weight of wax inside water = 25 – 17 = 8g

$\because F_T = V\rho g$

$(18 - 8)g = V\rho g$ ....(i)

$F_b = Vdg$

$18g = Vdg$ ...(ii)

By eq. (i) and (ii)

$\frac{d}{\rho} = \frac{18}{10}$

3. **(1)**

$F_n = F_g - F_T$

$= Vd_1g - Vd_2g$

$= Vd_1g(1 - \frac{d_2}{d_1})$

$= Mg(1 - \frac{d_2}{d_1})$

4. **(3)**

$V_i\rho_w g = V\rho_s g$

$S.G = \frac{\rho_s}{\rho_w} = \frac{V_i}{V} = \frac{3}{4}$

5. **(3)**

ρ_r for solid $= \frac{12}{120-80} = 3$

ρ_r for liquid $= \frac{120-60}{120-80} = \frac{3}{2}$

6. **(4)**

7. **(1)**

$\frac{\rho_s}{\rho_w} = \frac{w}{w-w_{app}} = \frac{15}{15-12} = 5$

8. **(2)**

9. **(3)**

$$\frac{\rho_s}{\rho_w} = \frac{210}{210-180}$$

$$= \frac{210}{30} = 7 \times 10^3 \mathrm{kg/m^3}$$

10. **(1)**

$V_1\rho_{Hg}\,g + V_2\rho_w\,g = (V_1 + V_2)\,\rho_s\,g$

$V_1(13.6)g + V_2(1)g = (V_1 + V_2) \times 7.8 \times g$

$13.6V_1 + V_2 = 7.8V_1 + 7.8V_2$

$6.8V_2 = 7.8V_1$

$$\frac{V_2}{V_1} = \frac{7.8}{6.8}$$

$$\frac{V_2}{V_1+V_2} \approx 0.54$$

11. **(3)**

$$F_{b(oil)} + F_{b(water)} = mg$$

$$P_{oil}V_{in}g + P_wV_{in}g = mg$$

$= 0.6 \times (10 \times 10 \times 6) \times g + 1 \times (10 \times 10 \times 4) \times g = mg$

$360 + 400 = m$

$M = 760$ gm

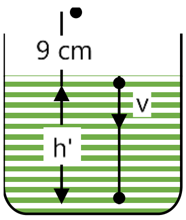
12. **(1)**

13. **(2)**

14. **(3)**

Velocity of ball when ball enters in water

$$v = \sqrt{2gh}$$



In water the ball moves with constant retardation

$$a = g\left(\frac{\rho_w}{\rho_B} - 1\right)$$

From 3rd equation of motion

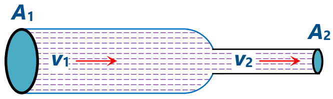
$v^2 = u^2 + 2as$

$$0 = 2gh - 2g\left(\frac{\rho_w}{\rho_B} - 1\right)h'$$

$$h' = \frac{h}{\left(\frac{\rho_w}{\rho_B} - 1\right)} = \frac{9}{\left(\frac{10^3}{0.4 \times 10^3} - 1\right)} = \frac{9}{(2.5-1)} = 6 \text{ cm}$$

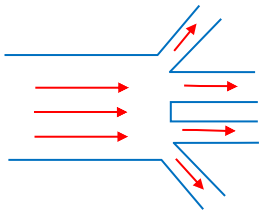
Equation of Continuity DPP-07

1. **A liquid flows in a tube from left to right as shown in figure. A_1 and A_2 are the cross-sections of the portions of the tube as shown. Then the ratio of speeds v_1/v_2 will be**



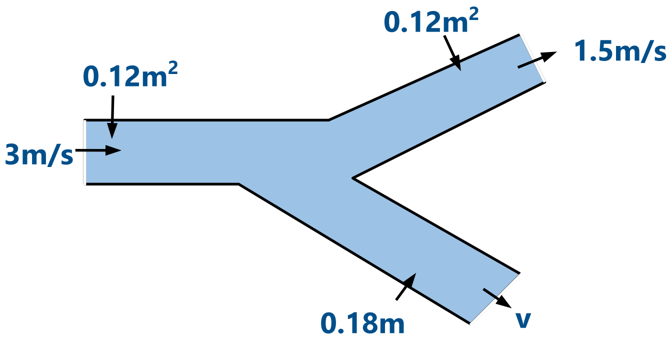
(1) A_1/A_2 (2) A_2/A_1 (3) $\sqrt{A_2}/\sqrt{A_1}$ (4) $\sqrt{A_1}/\sqrt{A_2}$

2. **Water is flowing through a channel that is 12 m wide with a speed of 0.75 m/s. The water then flows into four identical channels that have a width of 4.0m. The depth of the water does not change as it flows into the four channels. What is speed of the water in one of the smaller channels?**



(1) 0.56 m/s (2) 2.3 m/s (3) 0.25 m/s (4) 0.75 m/s

3. **An incompressible liquid flow, as shown. The speed of the liquid in the lower branch will be**



(1) 1.0 m/s (2) 1.5 m/s (3) 2.5 m/s (4) 3.0 m/s

4. **The cylindrical tube of a spray pump has a cross-section of 8 cm^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 0.15 m/min, then find the speed with which the liquid is ejected through the holes.**

(1) 5m/s (2) 30m/s (3) 0.5m/s (4) 4m/s

Answer Key

Question	1	2	3	4
Answer	2	1	1	1

SOLUTIONS

1. **(2)**

$A_1V_1 = A_2 V_2$

$\frac{V_1}{V_2} = \frac{A_2}{A_1}$

2. **(1)**

$Av = A_1v_1 + A_2v_2 + A_3v_3 + A_4v_4$

$Av = 4(A_1v_1)$

$12 \times 0.75 = 4\ [4 \times v]$

$v = \frac{3}{4} \times 0.75$

$= 0.75 \times 0.75$

$v = 0.56$ m/s

3. **(1)**

$0.12 \times 3 = 0.12 \times 1.5 + 0.18 \times v$

$0.36 = 0.18 + 0.18 \times v$

$V = 1$m/s.

4. **(1)**

From equation of continuity

$A_1v_1 = A_2v_2$

$(8\times10^{-4})\times\left(\frac{0.15}{60}\right) = (40 \times 10^{-8}) \times v_2$

$\Rightarrow v_2 = 5$ m/s.

Bernoulli's Theorem DPP-08

1. Bernoulli's theorem is based on the law of conservation of–

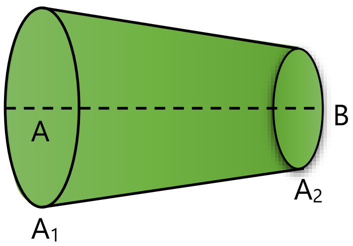
(1) Mass (2) Energy (3) Momentum (4) None of these

2. Water is flowing with a velocity of 2 m/s in a horizontal pipe with cross-sectional area decreasing from 2×10^{-2} m^2 to 0.01 m^2 at pressure 4×10^4 pascal. The pressure at smaller cross-section in pascal will be–

(1) 32 (2) 3.4 (3) 3.4×10^4 (4) 3.4×10^5

3. Water is flowing through a horizontal pipe of variable cross section.

Given $\frac{A_1}{A_2} = \frac{5}{3}$



Velocity of water at A is 6ms^{-1}. Pressure difference between points A and B will be nearly equal to

(1) $P_A - P_B = 0.72$ atm (2) $P_A - P_B = -0.54$ atm

(3) $P_A - P_B = 0.32$ atm (4) $P_A - P_B = 0$

4. Water is flowing through a horizontal pipe of non-uniform cross-section. At the extreme narrow portion of the pipe, the water will have

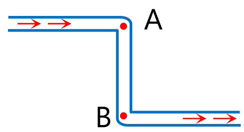
(1) Maximum speed and least pressure

(2) Maximum pressure and least speed

(3) Both pressure and speed maximum

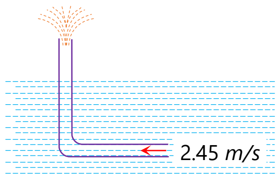
(4) Both pressure and speed least

5. **In this figure, an ideal liquid flows through the tube kept vertically, which is of uniform cross-section. The liquid has velocities v_A and v_B and pressure P_A and P_B at points A and B respectively**



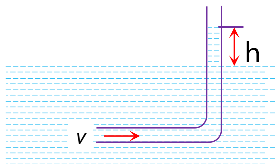
(1) $V_A < V_B$ (2) $V_B > V_A$ (3) $P_A = P_B$ (4) $P_B > P_A$

6. **An L-shaped tube with a small orifice is held in a water stream as shown in fig. The upper end of the tube is 10.6 cm above the surface of water. What will be the height of the jet of water coming from the orifice? Velocity of water stream is 2.45 m/s**



(1) Zero (2) 20.8 cm (3) 10.6 cm (4) 40.0 cm

7. **An L-shaped glass tube is just immersed in flowing water such that its opening is pointing against flowing water. If the speed of water current is *v*, then**



(1) The water in the tube rises to height $\frac{v^2}{2g}$

(2) The water in the tube rises to height $\frac{g}{2v^2}$

(3) The water in the tube does not rise at all

(4) None of these

8. **The pressure of water in a waterpipe when tap is opened and closed is 2×10^5 N/m^2 and 2.5×10^5N/m^2 respectively. Find the velocity of water flowing from open tap.**

(1) 100 m/sec (2) 10 m/sec (3) 5 m/sec (4) 15 m/sec

9. **In a horizontal pipe, the flowing oil pressure falls by 8 N/m^2 between two points separated by 1m. Find the change in kinetic energy per unit mass of oil at these points (ρ_{oil} = 800 kg/m^3)**

(1) 0.1 J/kg (2) 100 J/kg (3) 0.01 J/kg (4) 0.001 J/kg

Answer Key

Question	1	2	3	4	5	6	7	8	9
Answer	2	3	3	1	4	2	1	2	3

SOLUTIONS

1. **(2)**

2. **(3)**

$A_1V_1 = A_2V_2$

$2\times10^{-2}\times 2 = 0.01 \times V_2$

$V_2 = 4$ m/s

$P_1 + \frac{1}{2}\rho V_1^2 = P_2 + \frac{1}{2}\rho V_2^2$

$P_2 = 4 \times 10^4 + \frac{1}{2}\rho(V_1^2 - V_2^2)$

$P_2 = 4 \times 10^4 - 0.6\times10^4$

$P_2 = 3.4 \times 10^4$

3. **(3)**

$A_1V_A = A_2V_B$

$\Rightarrow V_B = 10ms^{-1}$

Bernoulli's theorem

$P_A + \frac{1}{2}\rho V_A^2 = P_B + \frac{1}{2}\rho V_B^2$ (same, hρg)

$P_A - P_B = \frac{1}{2}\rho(V_B^2 - V_A^2)$

$= \frac{1}{2} \times 10^3\ (100 - 36)$

$= 0.32 \times 10^5$

≈ 0.32 atm.

4. **(1)**

5. **(4)**

6. **(2)**

According to Bernoulli's theorem, $h = \frac{v^2}{2g}$

$\Rightarrow h = \frac{(2.45)^2}{2\times10} = 0.314 = 31.4$ cm

$\therefore$ Height of jet coming from orifice

$= 31.4 - 10.6 = 20.8$ cm

7. **(1)**

8. **(2)**

Applying Bernoulli's theorem –

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$$

$$2.5 \times 10^5 + 0 + 0 = 2 \times 10^5 + \frac{1}{2} \times 10^3 \times v^2 + 0$$

v = 10 m/sec

9. **(3)**

From Bernoulli's theorem –

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

$$\frac{1}{2}\rho(v_2^2 - v_1^2) = P_1 - P_2 = 8 N/m^2$$

$\therefore$ Change in kinetic energy per unit mass = $\frac{1}{2}(v_2^2 - v_1^2) = \frac{P_1 - P_2}{\rho} = \frac{8}{800} \Rightarrow 0.01 J/kg$

Torricelli's Law DPP-09

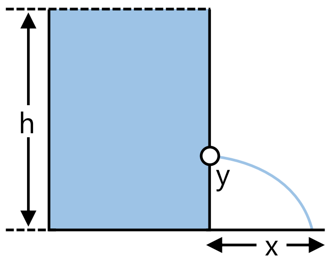
1. **There is a small hole of diameter 2 mm in the wall of a water tank at a depth of 10 m below free water surface. The velocity of efflux of water from the hole will be–**

(1) 0.14 m/s (2) 1.4 m/s (3) 0.014 m/s (4) 14 m/s

2. **A hole is made at the bottom of a tank filled with water (density = 10^3 kg/m^3). If the total pressure at the bottom of the tank is 3 atm (1 atm = 10^5 N/m^2), then the velocity of efflux is**

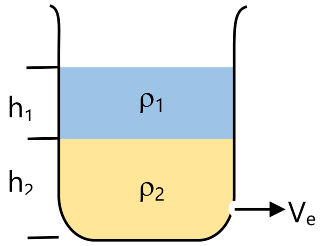
(1) $\sqrt{400}\,\text{m/s}$ (2) $\sqrt{200}\,\text{m/s}$ (3) $\sqrt{600}\,\text{m/s}$ (4) $\sqrt{500}\,\text{m/s}$

3. **A vessel is filled with water upto height h. A hole is made at height $y = \frac{h}{4}$ above the bottom. Water strikes the ground at distance x equals to–**



(1) h (2) $\frac{h}{\sqrt{3}}$ (3) $\frac{\sqrt{3}}{2}h$ (4) $\frac{h}{2\sqrt{3}}$

4. **A vessel is filled with two layers of liquids as shown. Efflux velocity V_e can be given by**



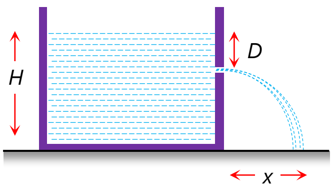
(1) $Ve = \sqrt{2g(h_1 + h_2)}$ (2) $Ve = \sqrt{2g\left(h_1 + \frac{\rho_1 h_2}{\rho_2}\right)}$

(3) $Ve = \sqrt{2g\left(h_2 + \frac{\rho_1 h_1}{\rho_2}\right)}$ (4) $Ve = \sqrt{2g\frac{h_1}{h_2}(\rho_1 + \rho_2)}$

5. **A sniper fires a rifle bullet into a gasoline tank making a hole 53.0 m below the surface of gasoline. The tank was sealed at 3.10 atm. The stored gasoline has a density of 660 kgm^{-3}. The velocity with which gasoline begins to shoot out of the hole is**

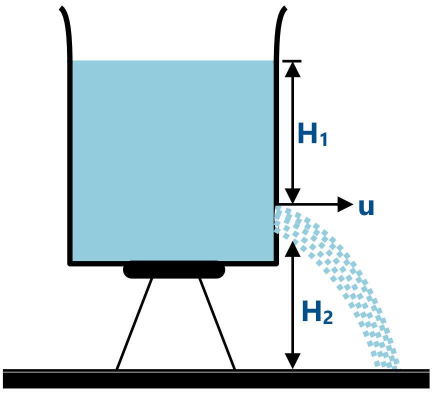
(1) $27.8\ ms^{-1}$ (2) $41.0\ ms^{-1}$ (3) $9.6\ ms^{-1}$ (4) $19.7\ ms^{-1}$

6. **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**



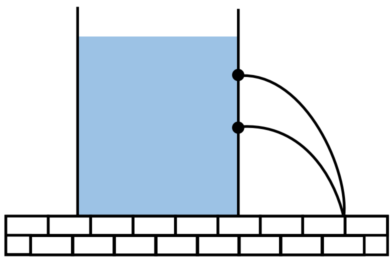
(1) $x = \sqrt{D(H-D)}$ (2) $x = \sqrt{\frac{D(H-D)}{2}}$ (3) $x = 2\sqrt{D(H-D)}$ (4) $x = 4\sqrt{D(H-D)}$

7. **A tank is filled with a liquid is placed on a platform then a small hole is punched on wall of this tank at distance H_1 from top of liquid and H_2 from ground then horizontal range of liquid is :-**



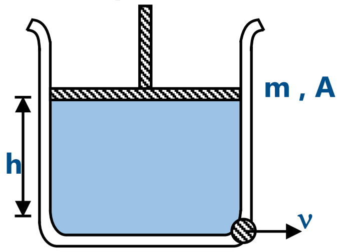
(1) $2\sqrt{H_1H_2}$ (2) $\frac{H_1+H_2}{2}$ (3) $\sqrt{H_1H_2}$ (4) $H_1 + H_2$

8. **In a cylindrical vessel containing liquid of density ρ, there are two holes in the side walls at heights of h_1 and h_2 respectively such that the range of efflux at the bottom of the vessel is same. The height of a hole for which the range of efflux would be maximum, will be –**



(1) $h_2 - h_1$ (2) $h_2 + h_1$. (3) $\frac{h_2-h_1}{2}$ (4) $\frac{h_2+h_1}{2}$

9. **A cylindrical vessel contains a liquid of density ρ upto a height h. The liquid is closed by a piston of mass m and area of cross-section A. There is a small hole at the bottom of the vessel. The speed v with which the liquid comes out of the hole is –**



(1) $\sqrt{2gh}$

(2) $\sqrt{2\left(gh + \frac{mg}{\rho A}\right)}$

(3) $\sqrt{2\left(gh + \frac{mg}{A}\right)}$

(4) $\sqrt{2gh + \frac{mg}{A}}$

Answer Key

Question	1	2	3	4	5	6	7	8	9
Answer	4	1	3	3	2	3	1	4	2

SOLUTIONS

1. **(4)**

$v = \sqrt{2gh} = \sqrt{2 \times 10 \times 10} \cong 14 \text{ m/sec.}$

2. **(1)**

$P_0 + \rho gh = 3\text{atm}$

$\rho gh = 2 \times 10^5 \Rightarrow gh = 2 \times 10^2$

$V = \sqrt{2gh} = \sqrt{2 \times 2 \times 10^2} = \sqrt{400} \text{ m/s}$

3. **(3)**

$v = \sqrt{2g\frac{3h}{4}}$

$T = \sqrt{\frac{2h}{4g}}$

Range $= x = vT = \frac{\sqrt{3}}{2} h$

4. **(3)**

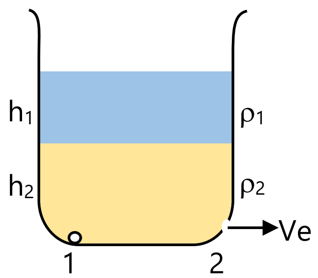
At 1 : $P_a + h_1\rho_1 g + h_2\rho_2 g$

At 2 : $P_a + \frac{1}{2}\rho_2 V_e^2$

$\Rightarrow \frac{1}{2}\rho_2 V_e^2 = g(h_1\rho_1 + h_2\rho_2)$

$V_e^2 = 2g\left(h_2 + \frac{\rho_1 h_1}{\rho_2}\right)$

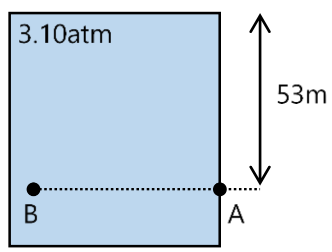
$V_e = \sqrt{2g\left(h_2 + \frac{\rho_1 h_1}{\rho_2}\right)}$



5. **(2)**

According to Bernoulli's theorem,

$P_B + h\rho g = P_A + \frac{1}{2}\rho v_A^2$ (As $v_A >> v_B$)



$3.10 \times 1.01 \times 10^5 + 53 \times 660 \times 10 = 1 \times 1.01 \times 10^5 + \frac{1}{2} \times 660 v_A^2$

$\Rightarrow 2.1 \times 1.01 \times 10^5 + 3.498 \times 10^5 = \frac{1}{2} \times 660 \times v_A^2$

$\Rightarrow 5.619 \times 10^5 = \frac{1}{2} \times 660 \times v_A^2$

$\therefore v_A = \sqrt{\frac{2 \times 5.619 \times 10^5}{660}} = 41 \text{ m/s}$

6. **(3)**

Time taken by water to reach the bottom

$= t = \sqrt{\frac{2(H-D)}{g}}$

and velocity of water coming out of hole, $v = \sqrt{2gD}$

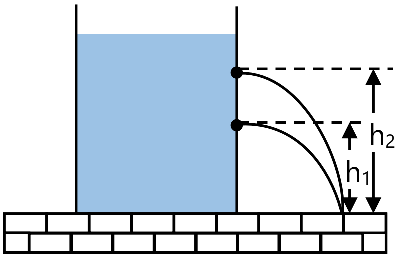
$\therefore$ Horizontal distance covered $x = v \times t$

$= \sqrt{2gD} \times \sqrt{\frac{2(H-D)}{g}} = 2\sqrt{D(H-D)}$

7. **(1)**

Range (R) = $V_xT = \sqrt{2gH_1}\sqrt{\frac{2H_2}{g}} = 2\sqrt{H_1H_2}$

8. **(4)**

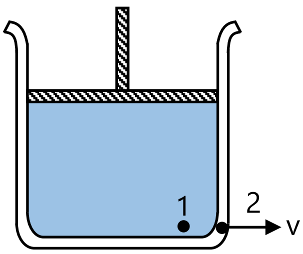


If H is the height of the liquid surface then for same range $h_2 = H - h_1$.

and for maximum range $h = \frac{H}{2} = \frac{h_1 + h_2}{2}$

9. **(2)**

Applying Bernoulli's theorem at 1 and 2 : difference in pressure energy between 1 and 2 = difference in kinetic energy between 1 and 2



or $\rho gh + \frac{mg}{A} = \frac{1}{2}\rho v^2$

or $v = \sqrt{2gh + \frac{2mg}{\rho A}} = \sqrt{2\left(gh + \frac{mg}{\rho A}\right)}$

DAILY PRACTICE PROBLEM

Dynamic Lift DPP-10

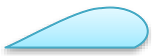
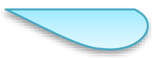
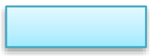
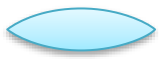
1. An application of Bernoulli's equation for fluid flow is found in

(1) Dynamic lift of an aeroplane
(2) Viscosity meter
(3) Capillary rise
(4) Hydraulic press

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

(1) Upthrust of the air which will be equal to the weight of the air having the same volume as the plane
(2) Force due to the pressure difference between the upper and lower surfaces of the wings, created by different air speeds on the surface
(3) Vertical component of the thrust created by air currents striking the lower surface of the wings
(4) Force due to the reaction of gases ejected by the revolving propeller

3. Fig. represents vertical sections of four wings moving horizontally in air. In which case the force is upwards

(1) 
(2) 
(3) 
(4) 

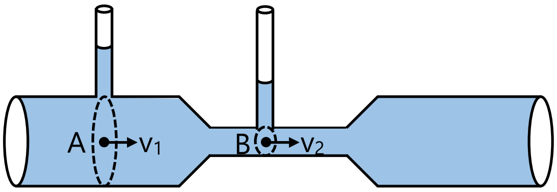
4. An aeroplane of weight 5×10^5 N and total wing area of 250 m^2 is in a level flight at some height. Find the difference in pressure between the upper and lower surfaces of its wings. ($g = 10\ m/s^2$)

(1) 20 kPa
(2) 2 kPa
(3) 200 kPa
(4) 0.2 kPa

5. The flow speeds of air on the lower and upper surfaces of the wing of an aeroplane are v and 2v respectively. The density of air is ρ and surface area of wing is A. Find the dynamic lift on the wing.

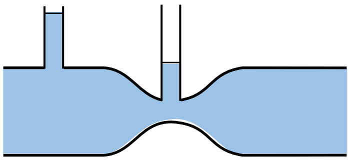
(1) $\frac{1}{2}\rho Av^2$
(2) $\frac{3}{2}\rho Av^2$
(3) $\frac{5}{2}\rho Av^2$
(4) $2\rho Av^2$

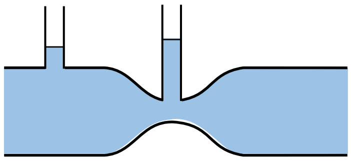
6. Water is flowing in a venturi meter as shown in the diagram. The cross sectional area at points A and B are $10m^2$ and $6m^2$ respectively and pressure difference at points A and B is 2 atm then find out the rate of flow of water at point A. ($g=10m/s^2$)

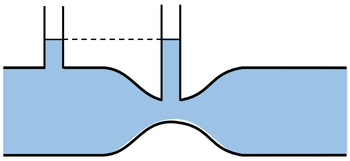


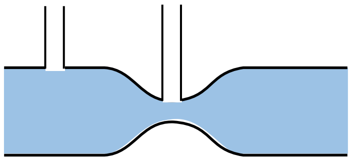
(1) 15 m^3/sec
(2) 30 m^3/sec
(3) 150 m^3/sec
(4) 45 m^3/sec

7. For a fluid which is flowing steadily, the level in the vertical tubes is best represented by -

(1)


(2)


(3)


(4)


Answer Key

Question	1	2	3	4	5	6	7
Answer	1	2	1	2	2	3	1

SOLUTIONS

1. **(1)**

2. **(2)**

3. **(1)**

4. **(2)**

$$\Delta P = \frac{Mg}{A} = \frac{5\times10^5}{250} = 2\times10^3\,Pa = 2kPa$$

5. **(2)**

Dynamic lift = Pressure difference × Area

= $(P_{lower} - P_{upper})A$

According to Bernoulli's theorem

$$= \left(\frac{1}{2}\rho v_{upper}^2 - \frac{1}{2}\rho v_{lower}^2\right)A$$

$$= \frac{1}{2}\rho A\left((2v)^2 - (v)^2\right)$$

$$= \frac{3}{2}\rho A v^2$$

6. **(3)**

$P_A - P_B = \rho gh$

$2 \times 10^5 = (10)^3(10)h$

$h = 20$ m

$$v_1 = A_2\sqrt{\frac{2gh}{A_1^2 - A_2^2}}$$

$$v_1 = 6\sqrt{\frac{2gh}{A_1^2 - A_2^2}}$$

Rate of flow = A_1v_1

= (10) (15) = 150 m^3/sec

7. **(1)**

DAILY PRACTICE PROBLEM

Bodies on Liquid Surface DPP-11

1. The length of a needle floating on water is 4 cm. Calculate the additional force required to pull the needle out of water. [T = 7 × 10^{-2} N/m]

(1) 2.8×10^{-3} N
(2) 5.6×10^{-4} N
(3) 2.8×10^{-4}N
(4) 5.6×10^{-3} N

2. Find the maximum weight of needle which can float on water having surface tension 0.073 N/m. Length of needle is 1 cm.

(1) 0.73×10^{-3} N
(2) 0.073×10^{-2} N
(3) 1.46×10^{-3}N
(4) 1.46×10^{-4} N

3. The ring of radius 1m is lying on the surface of liquid. It is lifted from the liquid surface by an extra force of 4 N other than its weight in such a way that the liquid film in it remains intact. The surface tension of liquid will be–

(1) $\frac{1}{2\pi}$ N/m
(2) $\frac{1}{\pi}$ N/m
(3) $\frac{1}{3\pi}$ N/m
(4) $\frac{1}{4\pi}$ N/m

4. Liquid drops are falling slowly one by one from a vertical glass tube. Relation between the weight of a drop w, the surface tension T and the radius of the tube is (assume the angle of contact to be zero)

(1) $w = \pi r^2 T$
(2) $w = 2\pi r T$
(3) $w = 2\pi r^2 T$
(4) $w = \frac{4}{3}\pi r$

5. Radius of a capillary is 2 × 10^{-3} m. A liquid of weight 6.2 × 10^{-4} N may remain in the capillary. Then the surface tension of liquid will be:

(1) 5×10^{-3} N/m
(2) 5×10^{-2} N/m
(3) 5 N/m
(4) 50 N/m

Answer Key

Question	1	2	3	4	5
Answer	4	3	2	2	2

SOLUTIONS

1. **(4)**

$F = T(2\ell)$

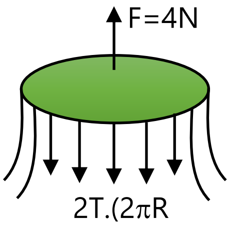
$F = (7 \times 10^{-2})(2 \times 4 \times 10^{-2})$

$F = 5.6 \times 10^{-3}$ N

2. **(3)**

$W_{max} = 2T\ell = 2(0.073)(1\times10^{-2}) = 1.46 \times 10^{-3}$ N

3. **(2)**



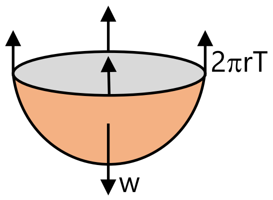
$T = 4T\,\pi R$

$T = 4\times T\times\pi\times1$

$T = \frac{1}{\pi}$

4. **(2)**

$w = 2\pi rT$



5. **(2)**

$2\pi RT\cos\theta = mg \; (\theta = 0°)$

$$T = \frac{mg}{2\pi R} = \frac{6.2\times10^{-4}}{2\times3.14\times2\times10^{-3}}$$

$T = 5 \times 10^{-2}$ N/m

Surface Energy DPP-12

1. If T is the surface tension of a liquid, then the energy needed to break a liquid drop of radius R into 64 equal drop is–

(1) $6\pi R^2 T$ (2) $\pi R^2 T$ (3) $12\pi R^2 T$ (4) $8\pi R^2 T$

2. The work done in blowing a soap bubble of 10 cm radius is (surface tension of soap solution is 0.03 N/m)

(1) 37.68×10^{-4} J (2) 75.36×10^{-4} J

(3) 126.82×10^{-4} J (4) 75.36×10^{-3} J

3. The surface tension of soap solution is 0.03 N/m. The work done in blowing to form a soap bubble of surface area 40 cm^2 is :-

(1) 1.2×10^{-4}J (2) 2.4×10^{-4}J (3) 12×10^{-4}J (4) 24×10^{-4}J

4. Work done in increasing the size of a soap bubble from a radius of 3 cm to 5cm is nearly (Surface tension of soap solution = 0.03 Nm^{-1}) :-

(1) 2π mJ (2) $0.4\ \pi$ mJ (3) 4π mJ (4) $0.2\ \pi$ mJ

5. When a drop splits up into a number of drops, then :-

(1) area decreases (2) volume increases

(3) energy is absorbed (4) energy is liberated

6. Area of liquid film is 6 × 10 cm^2 and surface tension is T = 20 dyne/cm. What is the work done to change area upto 12 × 10 cm^2 :–

(1) 120 J (2) 120 erg. (3) 1200 J (4) 2400 erg.

7. When a drop of water converts into many drops then its surface energy

(1) Increases (2) Decreases

(3) Remains same (4) Depends upon radius

8. A liquid drop of diameter D is divided into 27 equal droplets. If the surface tension is T then the change in energy will be–

(1) $3\pi D^2T$ (2) πD^2T (3) $2\pi D^2T$ (4) $4\pi D^2T$

9. **A rectangular film of a certain liquid is 5cm long and 3cm wide. If the amount of work done in increasing its size to 6cm×5cm is 3×10^{-4} J then the value of surface tension of the liquid is–**

(1) 0.4 N/m (2) 0.1 N/m (3) 3×10^{-4} N/m (4) 5×10^{-4} N/m

10. **If the work done in blowing a bubble of volume V is W, then the work done in blowing a soap bubble of volume 2V will be–**

(1) W (2) 2W (3) $2^{1/3}$ W (4) $4^{1/3}$ W

11. **If T be the surface tension, the amount of work done in blowing a soap bubble from diameter d to diameter D is:**

(1) $\pi(D^2 - d^2)T$ (2) $2\pi(D^2 - d^2)T$ (3) $4\pi(D^2 - d^2)T$ (4) $8\pi(D^2 - d^2)T$

12. **The work done in increasing the size of a rectangular film from 10 cm × 6 cm to 10 cm × 11 cm is 3×10^{-4} joule. The surface tension of the film is -**

(1) 1.5×10^{-2} N/m (2) 3.0×10^{-2} N/m

(3) 6.0×10^{-2} N/m (4) 11.0×10^{-2} N/m

13. **A soap bubble having radius $\frac{1}{\sqrt{\pi}}$ cm is expanded to a bubble of radius $\frac{2}{\sqrt{\pi}}$ cm. If the surface tension of soap solution is 0.03 Nm^{-1}. The work done is: -**

(1) 0.36 J (2) 3.6×10^{-5} J (3) 7.2×10^{-5} J (4) 0.72 J

Answer Key

Question	1	2	3	4	5	6	7	8	9	10	11	12	13
Answer	3	2	2	2	3	4	1	3	2	4	2	2	3

SOLUTIONS

1. **(3)**

$\because$ R = $(64)^{\frac{1}{3}}r \Rightarrow$ R = 4r

w = $4\pi TR^3 \left(\frac{1}{r} - \frac{1}{R}\right)$

= $4\pi TR^3 \left(\frac{4}{R} - \frac{1}{R}\right)$

w = $12\pi TR^2$

2. **(2)**

w = TA

= $0.03 \times 8 \times 3.14 \times 100 \times 10^{-4}$

= 15.36×10^{-4} J

3. **(2)**

In case of soap bubble,

W = T × 2 × ΔA

= $0.03 \times 2 \times 40 \times 10^{-4} = 2.4 \times 10^{-4}$J.

4. **(2)**

W = $8\pi (r^2{}_2 - r_1{}^2)$ T

5. **(3)**

6. **(4)**

W = T(2ΔA)

W = 20[2 × (12×10 – 6 × 10)]

W = 2400 erg

7. **(1)**

8. **(3)**

w = $4\pi R^2 T (N^{1/3} - 1)$

= $\pi(4R^2)T (27^{1/3} - 1)$

= $\pi D^2 T (3 - 1)$

= $2\pi D^2 T$

9. **(2)**

$W = T\Delta A$

$3 \times 10^{-4} = T \times 2(30-15) \times 10^{-4}$

$30T = 3 \Rightarrow T = 0.1$ N/m

10. **(4)**

$W = T\Delta A$

$V \propto r^3$ and $A \propto r^2$

$\Rightarrow A \propto V^{2/3}$

$W \propto A \propto V^{2/3}$

$\frac{W'}{W} = 2^{2/3} = 4^{1/3}$

11. **(2)**

Work done $= 8\pi T[r_2^2 - r_1^2]$

$= 8\pi T[\frac{D^2}{4} - \frac{d^2}{4}]$

$= 2\pi T[D^2 - d^2]$

12. **(2)**

$W = T(2\Delta A)$

$3 \times 10^{-4} = T \times 2 \times (10 \times 11 - 10 \times 6) \times 10^{-4}$

$T = 3 \times 10^{-2}$ N/m

13. **(3)**

$W = \Delta U = T(8\pi R_2^2 - 8\pi R_1^2)$

$\Rightarrow W = 8\pi \times 0.03 \left\{\frac{4}{\pi} - \frac{1}{\pi}\right\} \times 10^{-4}$ J

$\Rightarrow W = 7.2 \times 10^{-5}$ J

Excess Pressure DPP-13

1. **An air bubble of radius R is formed at a depth h inside the container of soap solution of density ρ. If P_0 is the atmospheric pressure, then the total pressure inside the air bubble is (Surface tension of soap solution is T)–**

(1) $\frac{2T}{R} + h\rho g$ (2) $\frac{2T}{R} - h\rho g$ (3) $P_0 + \frac{2T}{R} + h\rho g$ (4) $P_0 + \frac{2T}{R} - h\rho g$

2. **Pressure inside two soap bubbles is 1.01 and 1.02 atmosphere. Ratio between their volumes is–**

(1) 102 : 101 (2) $(102)^3 : (101)^3$ (3) 8 : 1 (4) 2 : 1

3. **A soap bubble in air has surface tension 0.03 Nm^{-1}. The excess pressure inside a bubble of diameter 30 mm is–**

(1) 2 Pa (2) 4 Pa (3) 16 Pa (4) 8 Pa

4. **Ratio of volumes of two soap bubbles is 8 : 1. Ratio of excess pressures will be–**

(1) 8 : 1 (2) 1 : 4 (3) 1 : 2 (4) 2 : 1

5. **An air bubble is formed at depth h below the surface of water. The pressure inside the bubble is–**
(P_0 = atmospheric pressure; r = radius of bubble, T = surface tension)

(1) $\frac{2T}{r}$ (2) $\frac{4T}{r}$ (3) $P_0 + h\rho g + \frac{2T}{r}$ (4) $P_0 + h\rho g + \frac{4T}{r}$

6. **Two soap bubbles of radii 2cm and 3cm come in contact. Radius of curvature of their common surface is equal to**

(1) 5cm (2) 6cm (3) 1.5cm (4) 1cm

7. **If the excess pressure inside a liquid drop is 3 times of excess pressure of another liquid drop made from same liquid. Find ratio of their volumes.**

(1) $\frac{1}{9}$ (2) $\frac{1}{3}$ (3) $\frac{1}{27}$ (4) $\frac{1}{81}$

8. **If the excess pressure inside a soap bubble is 8 mm of water column and radius is 0.1 mm. Find the surface tension of bubble.**

(1) 2×10^{-3} N/m (2) 4×10^{-3} N/m (3) 2×10^{-4} N/m (4) 4×10^{-4} N/m

9. **The excess pressure due to surface tension inside a spherical drop is 9 unit. If 27 such drops combine then find the excess pressure due to surface tension inside the larger drop.**

(1) 9 unit (2) 3 unit (3) 27 unit (4) 1 unit

10. **If a section of liquid drop (of radius R) through its centre is considered then find the force on one half due to surface tension (T).**

(1) $2\pi rT$ (2) $4\pi rT$ (3) πrT (4) $8\pi rT$

Answer Key

Question	1	2	3	4	5	6	7	8	9	10
Answer	3	3	4	3	3	2	3	1	2	1

SOLUTIONS

1. **(3)**

$$P = P_0 + h\rho g + \frac{2T}{R}$$

2. **(3)**

$\Delta P_1 = (1.01 - 1)$ atm $= 0.01$ atm

$\Delta P_2 = (1.02 - 1)$ atm $= 0.02$ atm

$$\frac{\Delta P_1}{\Delta P_2} = \frac{r_2}{r_1} = \frac{2}{1}$$

$$\frac{V_1}{V_2} = \frac{r_1^3}{r_2^3} = \frac{8}{1}$$

3. **(4)**

$$P = \frac{4T}{R}$$

4. **(3)**

$P_{excess} = \dfrac{4T}{r}$ and $v \propto r^3$

$v_1 : v_2 = 8 : 1 \Rightarrow r_1 : r_2 = 2 : 1$

$P_{excess} \propto \dfrac{1}{r}$

5. **(3)**

$P_{out} = P_0 + h\rho g$

$$P_{in} = P_{out} + \frac{2T}{r} = P_0 + h\rho g + \frac{2T}{r}$$

6. **(2)**

$$\frac{1}{r_c} = \frac{1}{r_1} - \frac{1}{r_2}$$

$$\Rightarrow \ r_c = \frac{r_1 r_2}{r_2 - r_1} = \frac{2\times 3}{3-2} = 6\text{cm}$$

7. **(3)**

$$\left(\frac{2T}{r_1}\right) = 3\left(\frac{2T}{r_2}\right)$$

$$\frac{r_1}{r_2} = \frac{1}{3}$$

$$\because \frac{v_1}{v_2} = \left(\frac{r_1}{r_2}\right)^3 = \frac{1}{27}$$

8. **(1)**

$$\frac{4T}{r} = h\rho_w g$$

$$\frac{4T}{0.1\times10^{-3}} = (8 \times 10^{-3})\,(10^3)\,(10)$$

$T = 2 \times 10^{-3}$ N/m

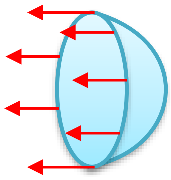
9. **(2)**

$$R = (n)^{\frac{1}{3}}.r = 3r$$

$$P_{ex} \propto \frac{1}{r} \Rightarrow \frac{(P_{ex})_{big}}{(P_{ex})_{small}} = \frac{r}{R} = \frac{1}{3}$$

P_{ex} = 3 unit

10. **(1)**



Surface tension = T

force due to surface tension will be = T $(2\pi r)$ = $2\pi rT$

DAILY PRACTICE PROBLEM

Angle of Contact DPP-14

1. The water proofing agent makes the angle of contact–

(1) from acute angle to obtuse angle (2) from obtuse angle to acute angle

(3) from obtuse angle to right angle (4) from acute angle to right angle

2. If a liquid neither rises nor falls in a capillary, its angle of contact is–

(1) 0° (2) 45° (3) 90° (4) 180°

3. A liquid will not wet a solid surface if the angle of contact is

(1) 0° (2) 30° (3) 45° (4) 120°

4. A liquid rises in a capillary tube then its angle of contact θ is

(1) $\theta = 90°$ (2) $\theta < 90°$ (3) $\theta > 90°$ (4) $\theta = 180°$

5. A liquid will wet a solid surface if the angle of contact is

(1) 105° (2) 40° (3) 120° (4) 155°

Answer Key

Question	1	2	3	4	5
Answer	1	3	4	2	2

SOLUTIONS

1. (1)

$\theta_c > 90°$ for water proof materials.

2. (3)

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

h = 0 for cos θ = 0

θ = 90°

3. (4)

4. (2)

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

5. (2)

DAILY PRACTICE PROBLEM

Capillary Tube and Capillarity DPP-15

1. Calculate the height to which water will rise in a capillary tube of diameter 14.6×10^{-3} m. [Given : Surface tension of water is 0.073 N/m, angle of contact is 0°, density of water is 1000 kg/m^3, g =10 m/s^2]

(1) 1 mm (2) 2 mm (3) 4 mm (4) 2 cm

2. A capillary tube of radius r can support a liquid of weight 6.28×10^{-4} N. If the surface tension of the liquid is 2×10^{-2} N/m. Then find radius of capillary tube.

(1) 10 mm (2) 1 mm (3) 5 mm (4) 0.5 mm

3. A capillary tube is dipped in water and it is 20 cm outside water. The water rises upto 8 cm. If the entire arrangement is put in freely falling elevator. The length of water column in the capillary tube will be–

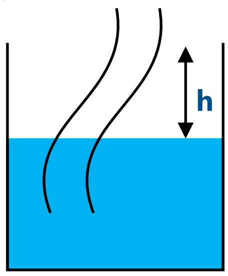
(1) 20 cm (2) 4 cm (3) 10 cm (4) 8 cm

4. If h is the height of capillary rise and r be the radius of capillary tube, then which of the following relation will be correct?

(1) hr = constant (2) $\frac{h}{r^2}$ = constant

(3) rh^2 = constant (4) $\frac{h}{r}$ = constant

5. Water rises in a straight capillary tube upto a height of 5 cm when held vertical in water. If the tube is bent as shown in figure then the height of water column in it will be–

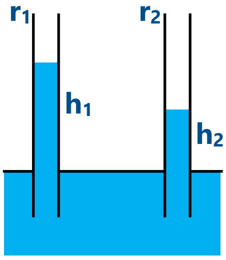


(1) 5 cm (2) less than 5 cm (3) more than 5 cm (4) 5 cos α

6. A liquid wets a solid completely. The meniscus of the liquid in a sufficiently long tube is–

(1) Flat (2) Concave (3) Convex (4) Cylindrical

7. **Two capillary tubes of cross sectional radii r_1 and r_2 are dipped in a liquid as shown. With respect outer surface U_1 and U_2 be the potential energies of liquid inside the tubes above outer surface. Then**



(1) $U_1 = U_2$ (2) $r_2U_1 = r_1U_2$ (3) $h_1U_1 = h_2U_2$ (4) $r_1U_1 = r_2U_2$

8. **When liquid rises in a capillary tube the upward pull due to surface tension is equal to**

(1) Weight of the liquid column (2) Cohesive forces
(3) Surface energy per unit area (4) Viscous force

9. **If the diameter of capillary tube be doubled, the rise of water in capillary will be**

(1) Double (2) Half (3) Remain the same (4) Four times

10. **A capillary tube of radius 0.2 cm is dipped vertically in a beaker containing liquid. If the liquid rises to a height of 5 cm for which the angle of contact is 60°, then surface tension of the liquid is :-**

(1) 49 dyne/cm (2) 98 dyne/cm (3) 490 dyne/cm (4) 980 dyne/cm

11. **Two capillaries of same material but of different radii are dipped in a liquid. In one of the capillary the liquid rises to a height of 22 cm and in other to 66 cm. The ratio of their radii is :-**

(1) 9 : 1 (2) 1 : 9 (3) 3 : 1 (4) 1 : 3

12. **In a capillary tube experiment, a vertical 50 cm long capillary tube is dipped in water. The water rises up to a height of 20 cm due to capillary action. If this experiment is conducted in a freely falling elevator, the length of the water column becomes :**

(1) 50 cm (2) 20 cm (3) 30 cm (4) Zero

Answer Key

Question	1	2	3	4	5	6	7	8	9	10	11	12
Answer	2	3	1	1	1	2	1	2	2	4	3	1

SOLUTIONS

1. **(2)**

$h = \frac{2T\cos\theta_C}{r\rho g}$

$h = \frac{2\times0.073\times\cos 0°}{(7.3\times10^{-3})(10^3)(10)} = 2\times10^{-3}\text{m} = 2\text{mm}$

2. **(3)**

T (2πr) = mg

$r = \frac{mg}{2\pi T} = \frac{6.28\times10^{-4}}{2\times3.14\times2\times10^{-2}} = 5\times10^{-3}\text{m} = 5\text{mm}$

3. **(1)**

When g = 0 then water rises up to top.

4. **(1)**

$h = \frac{2T}{r\rho g}$

$hr = \frac{2T}{\rho g}$ = constant

5. **(1)**

Height independent of shape.

6. **(2)**

7. **(1)**

$h_1r_1 = h_2r_2$

$U_1 = (\pi r_1^2 h_1\rho)g\left(\frac{h_1}{2}\right) = \frac{1}{2}\pi\rho g(h_1r_1)^2$

$U_2 = (\pi r_2^2 h_2\rho)g\left(\frac{h_2}{2}\right) = \frac{1}{2}\pi\rho g(h_2r_2)^2$

$\Rightarrow U_1 = U_2$

8. **(2)**

9. **(2)**

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

$\Rightarrow h \propto \frac{1}{r}$

10. **(4)**

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

$5 \times 10^{-2} = \frac{2\times T\times\cos60°}{10^3\times9.8\times0.2\times10^{-2}}$

T = 0.98 N/m

= 980 dyne/cm

11. **(3)**

$h \propto \frac{1}{r}$

$\frac{r_1}{r_2} = \frac{h_2}{h_1} = \frac{66}{22} = \frac{3}{1}$

12. **(1)**

$\because g_{eff} = 0$

Then height = 50 cm

DAILY PRACTICE PROBLEM

Newton's Law of Viscosity DPP-16

1. The relative velocity of two consecutive layers is 8 cm/s. It the perpendicular distance between the layers is 0.1 cm, then the velocity gradient will be–

(1) 8 sec^{-1} (2) 80 sec^{-1} (3) 0.8 sec^{-1} (4) 0.08 sec^{-1}

2. A plate of area 100 cm^2 is placed on the upper surface of castor oil, 2 mm thick. Taking the coefficient of viscosity 10 poise, the horizontal force necessary to move the plate with a uniform velocity of 2 cm/s is

(1) 1 N (2) 2 N (3) 0.1 N (4) 0.2 N

3. There is a 1 mm thick layer of glycerine between a plate of area 100 cm^2 and a large plate. If the coefficient of viscosity of glycerine is 1.0 kg/ms, then what force is required to move the smaller plate with a velocity of 7 cm/s.

(1) 0.75 (2) 0.07 (3) 0.7 (4) 7

4. There is a 3mm thick layer of glycerine between a plate of area 10^{-3} m^2 and a large plate. If the coefficient of viscosity of glycerine is 2 kg/ms, then what force is required to move the smaller plate with a velocity of 12 cm/s.

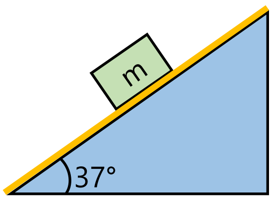
(1) 8N (2) 0.8N (3) 0.08N (4) 1.6N

5. The velocity of water in a river is 15 m/s near the surface. If the river is 5m deep, find the shearing stress between the horizontal layers of water. The coefficient of viscosity of water = 10^{-2} poise.

(1) 3×10^{-2} N/m^3 (2) 0.33×10^{-2} N/m^3

(3) 3.3×10^{-2} N/m^3 (4) 3×10^{-3} N/m^3

6. A cubical block of side 'a' and density 'ρ' slides over a fixed inclined plane with constant velocity 'v'. There is a thin film of viscous fluid of thickness 't' between the plane and the block. Then find the coefficient of viscosity of the thin film.



(1) $\frac{3\rho agt}{5v}$ (2) $\frac{4\rho agt}{5v}$ (3) $\frac{5\rho agt}{3v}$ (4) $\frac{5\rho agt}{4v}$

7. **The velocity of water in a river is 18 km/h at the surface. If the river is 5 m deep and the flow is streamlined, find the shearing stress between the horizontal layers of water assuming uniform velocity gradient. Viscosity of water is 10^{-3} Poiseuille.**

(1) 1×10^{-4} N/m^2
(2) 1×10^{-3} N/m^2
(3) 3×10^{-2} N/m^2
(4) 2×10^{-4} N/m^2

8. **Velocity of water in a river is**

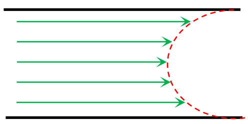
(1) Same everywhere
(2) More in the middle and less near its banks
(3) Less in the middle and more near its banks
(4) Increase from one bank to other bank

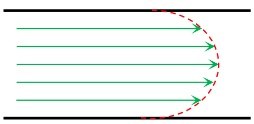
9. **A viscous fluid is flowing through a cylindrical tube. The velocity of the liquid in contact with the walls of the tube is**

(1) Zero
(2) Maximum
(3) In between zero and maximum
(4) Equal to critical velocity

10. **A viscous fluid is flowing through a cylindrical tube. The velocity distribution of the fluid is best represented by the diagram**

(1) 

(2) 

(3) 

(4) None of these

Answer Key

Question	1	2	3	4	5	6	7	8	9	10
Answer	2	3	3	3	2	1	2	2	1	3

SOLUTIONS

1. **(2)**

$\frac{dv}{dx} = \frac{8}{0.1} = 80$ per sec.

2. **(3)**

$F = \frac{\eta A v}{\ell} = \frac{1 \times 100 \times 10^{-4} \times 2 \times 10^{-2}}{2 \times 10^{-3}} = 0.1\ N$

3. **(3)**

Required force $F = \eta A \frac{\Delta v}{\Delta x} = \frac{1.0 \times 100 \times 10^{-4} \times (7 \times 10^{-2})}{10^{-3}} = 0.7\ N$

4. **(3)**

$F = \eta A \frac{\Delta v}{\Delta y} = \frac{2 \times 10^{-3} \times 12 \times 10^{-2}}{3 \times 10^{-3}} = 0.08N$

5. **(2)**

Velocity gradient $\frac{\Delta v}{\Delta y} = \frac{15}{5} = 3s^{-1}$

shearing stress $= \frac{F}{A} = \eta \frac{\Delta v}{\Delta y} \Rightarrow 3 \times 10^{-3} N/m^2$

6. **(1)**

$F = \eta A \frac{dv}{dy}$

$mg \sin 37^\circ = \eta A \frac{dv}{dy}$

$\Rightarrow (a^3 \rho) g \times \frac{3}{5} = \eta . a^2 . \frac{v}{t}$

$\Rightarrow \eta = \frac{3\rho agt}{5v}$

7. **(2)**

As velocity at the bottom of the river will be zero,

Velocity gradient $\frac{dy}{dy} = \frac{18 \times 10^3}{60 \times 60 \times 5} = 1s^{-1}$

Shear stress $= \frac{F}{A} = \eta \frac{dv}{dy} = 10^{-3} \times 1 = 1 \times 10^{-3}\ N/m^2$.

8. **(2)**

More in the middle and less near its banks

9. **(1)**

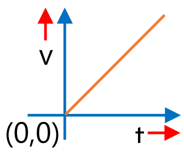
Zero

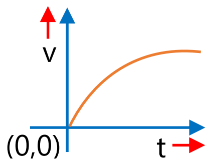
10. **(3)**

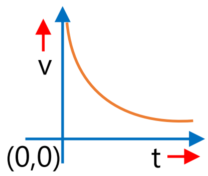
DAILY PRACTICE PROBLEM

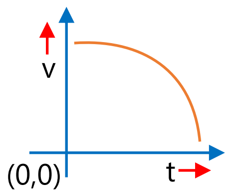
Stokes' Law and Terminal Velocity DPP-17

1. **A spherical ball is dropped in a long column of viscous liquid. The speed v of the ball varies as function of time as–**

(1) 

(2) 

(3) 

(4) 

2. **If a ball is thrown in viscous liquid with a speed greater than terminal speed in same direction of terminal speed than–**

(1) Its speed increases upto infinite
(2) Its speed remains constant
(3) Its speed decreases and become constant
(4) Its speed decreases and become zero

3. **A spherical body of diameter 'D' is falling in viscous medium. Its terminal velocity v_t is proportional to :-**

(1) $v_t \propto D^{1/2}$ (2) $v_t \propto D^{3/2}$ (3) $v_t \propto D^2$ (4) $v_t \propto D^{5/2}$

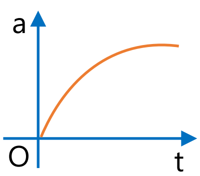
4. **Two drops of water which are falling in air are having mass ratio 1 : 27, what will be ratio of their terminal speed–**

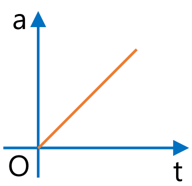
(1) 1 : 9 (2) 1 : 4 (3) 1 : 3 (4) 3 : 1

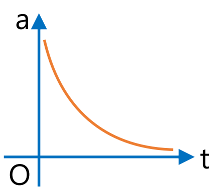
5. **An oil drop falls through air with a terminal velocity of 2×10^{-4} m/s. Viscosity of air is $10^{-5}\ \frac{N-s}{m^2}$ and density of oil is 900 kg/m³ and g = 10 m/s². Neglect the density of air as compared to that of oil, the radius of the drop is–**

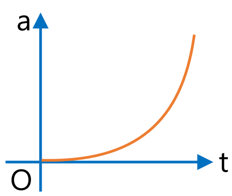
(1) 10^{-3} m (2) 10^{-4} m (3) 10^{-5} m (4) 10^{-6} m

6. **An iron sphere is dropped into a viscous liquid. Which of the following represents its acceleration (a) versus time (t) graph?**

(1) 

(2) 

(3) 

(4) 

7. Two equal drops are falling through air with a steady velocity of 5 cm/second. If two drops coalesce to form one drop then new terminal velocity will be–

(1) $5 \times (4)^{1/3}$ cm/s (2) $5\sqrt{2}$ cm/s

(3) $\frac{5}{\sqrt{2}}$ cm/s (4) 10 cm/s

8. In a viscous medium terminal velocity (v) of a spherical body depends on its radius (r) as–

(1) $v \propto r^{1/2}$ (2) $v \propto r^{3/2}$ (3) $v \propto r$ (4) $v \propto r^2$

9. A small lead ball is falling freely in a viscous liquid. The velocity of the ball

(1) Goes on increasing (2) Goes on decreasing

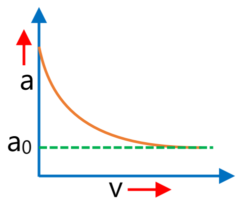
(3) Remains constant (4) First increases and then becomes constant

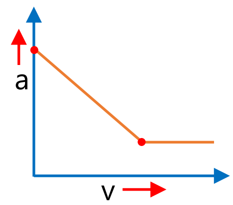
10. A spherical body is moving in a viscous medium. Viscous force on the body does not depend on

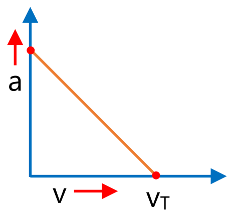
(1) Radius of the body (2) Density of the body

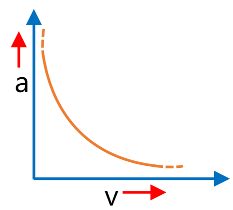
(3) Velocity of the body (4) Viscosity of the medium

11. A small spherical body is released from rest in a viscous medium. Its acceleration (a) varies with velocity (v) as

(1) 

(2) 

(3) 

(4) 

12. 27 identical drops of water are falling down vertically in air each with a terminal velocity 0.15 ms^{-1}. If they combine to form a single bigger drop. What will be its terminal velocity?

(1) 0.3 ms^{-1} (2) 1.35 ms^{-1} (3) 0.45 ms^{-1} (4) zero

13. Estimate the speed of vertically falling raindrops from the following data. Radius of the drops = 0.02 cm viscosity of air = 1.8×10^{-4} poise g = 10 m/s^2 and density of water 10^3 kg/m^3 neglect density of air :-

(1) 10 m/s (2) 3m/s (3) 5 m/s (4) None of these

14. A metal sphere of radius 1 mm and mass 50 mg falls vertically in glycerine. Find the viscous force exerted by the glycerine on the sphere when the speed of the sphere is 1 cm/s. Density of glycerine = 1260 kg/m^3 and coefficient of viscosity at room temperature = 8.0 poise :-

(1) 3×10^{-4} N (2) 1.5×10^{-4} N (3) 6×10^{-6} N (4) 1.2×10^{-3} N

15. Spherical balls of radius 'r' are falling in a viscous fluid of viscosity 'η' with a velocity 'v'. The retarding viscous force acting on the spherical ball is

(1) Inversely proportional to 'r' but directly proportional to velocity 'v'

(2) Directly proportional to both radius 'r' and velocity 'v'

(3) Inversely proportional to both radius 'r' and velocity 'v'

(4) Directly proportional to 'r' but inversely proportional to 'v'

16. A small drop of water falls from rest through a large height h in air; the final velocity is

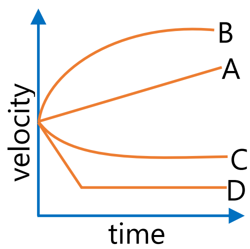
(1) $\propto \sqrt{h}$ (2) $\propto h$

(3) $\propto (1/h)$ (4) Almost independent of h

17. Eight drops of water, each of radius 2 mm are falling through air at a terminal velocity of 8 cm s^{-1}. If they coalesce to form a single drop, then the terminal velocity of combined drop will be :-

(1) 32 cm s^{-1} (2) 30 cm s^{-1} (3) 28 cm s^{-1} (4) 24 cm s^{-1}

18. A small ball is left in a viscous liquid from very much height. Correct graph of its velocity with time after it enters in liquid is :



(1) A (2) B (3) C (4) D

Answer Key

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Answer	2	3	3	1	4	4	1	4	4	2	3	2	3	2	2
Question	16	17	18												
Answer	4	1	3												

SOLUTIONS

1. **(2)**

2. **(3)**

3. **(3)**

$v = \frac{2r^2 g}{9\eta}(\rho_s - \rho_2) \Rightarrow v \propto r^2 \Rightarrow v \propto D^2$

4. **(1)**

$\frac{r_1}{r_2} = \left[\frac{m_1}{m_2}\right]^{\frac{1}{3}} = \left[\frac{1}{27}\right]^{\frac{1}{3}} = \frac{1}{3}$

$\because\ V \propto r^2$

$\frac{V_{T_1}}{V_{T_2}} = \frac{r_1^2}{r_2^2} = \left[\frac{1}{3}\right]^2 = \frac{1}{9}$

5. **(4)**

$v_T = \frac{2r^2(d-\rho)g}{9\eta}$

$2\times10^{-4} = \frac{2r^2\times900\times10}{9\times10^{-5}}$; $r = 10^{-6}$ m

6. **(4)**

7. **(1)**

$2 \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3$

$R = 2^{1/3}\ r$

Now, $V_T \propto r^2$

$V_T = 2^{2/3}\times5 = 4^{1/3}\times 5$

8. **(4)**

$v = \frac{2r^2 g}{9\eta}(\rho_s - \rho_2) \Rightarrow v \propto r^2$

9. **(4)**

First increases then attains terminal velocity which is constant.

10. (2)

$F_V = 6\pi\eta rv$

$\Rightarrow$ F_V ρ^o (independent of density)

11. (3)

$a = \frac{(W - Th) - 6\pi\eta rv}{m}$

Y = C – KX (straight line)

12. (2)

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

$v \propto r^2$

$\frac{v_1}{v_2} = \frac{r^2}{R^2} = \frac{1}{9}$

v = 9 × 0.15 = 1.35 m/sec.

13. (3)

Terminal velocity $= \frac{2}{9}\frac{(\sigma - \rho)r^2 g}{\eta}$

Substituting the values

$V_T = 5$m/s

14. (2)

$F = 6\pi\eta rv$

$F = 6 \times 3.14 \times 8 \times 10^{-1} \times 1 \times 10^{-3} \times 10^{-2}$

$= 1.5 \times 10^{-4}$ N

15. (2)

$F = 6\pi\eta rv$

16. (4)

$F = 6\pi\eta rv$

17. (1)

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

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

or R = 2r .....(i)

Terminal velocity, $v \propto r^2$

$\therefore \frac{v'}{v} = \frac{R^2}{r^2} = \left(\frac{2r}{r}\right)^2 = 4$ (Using (i))

or v' = 4v = 4 × 8 = 32 cm s^{-1}

18. (3)

Reynold's Number and Poiseuille's Equation DPP-18

1. If ρ = density, v = velocity, D = diameter and η = coefficient of viscosity. Reynold's number can be given by

(1) $\frac{\rho v}{\eta D}$ (2) $\frac{\rho v D}{\eta}$ (3) $\frac{\rho \eta}{v D}$ (4) $\frac{\eta v D}{\rho}$

2. The Reynolds number of a flow is the ratio of

(1) Gravity to viscous force (2) Gravity force to pressure force
(3) Inertia forces to viscous force (4) Viscous forces to pressure forces

3. Viscosity of gases–

(1) Increases by increasing temperature (2) Increases by decreasing temperature
(3) Increases by decreasing pressure (4) Increases by increasing pressure

4. The cause of viscosity in gases is–

(1) cohesive force (2) adhesive force
(3) diffusion (4) conductivity

5. As the temperature of water increases, its viscosity

(1) Remains unchanged
(2) Decreases
(3) Increases
(4) Increases or decreases depending on the external pressure

6. Water flows in a streamlined manner through a capillary tube of radius a, the pressure difference being P and the rate of flow Q. If the radius is reduced to a/2 and the pressure increased to 2P, the rate of flow becomes

(1) 4Q (2) Q (3) $\frac{Q}{4}$ (4) $\frac{Q}{8}$

7. When a viscous liquid flows at a rate Q through a tube of radius r placed horizontally, a pressure difference P develops across the ends of the tube. If the radius of the tube is doubled and rate of flow also doubled. Then find out the pressure difference across the ends of the tube.

(1) $\frac{P}{8}$ (2) 8P (3) $\frac{P}{16}$ (4) 16P

Answer Key

Question	1	2	3	4	5	6	7
Answer	2	3	1	1	2	4	1

SOLUTIONS

1. **(2)**

2. **(3)**

3. **(1)**

4. **(1)**

5. **(2)**

6. **(4)**

$Q = \frac{\pi p r^4}{8\eta l} \therefore Q \propto Pr^4$ (η and l are constants)

$\therefore \frac{Q_2}{Q_1} = \left(\frac{P_2}{P_1}\right)\left(\frac{r_2}{r_1}\right)^4 = 2 \times \left(\frac{1}{2}\right)^4 = \frac{1}{8} \therefore Q_2 = \frac{Q}{8}$

7. **(1)**

$Q = \frac{\pi P r^4}{8\eta \ell} \Rightarrow \frac{Q_1}{Q_2} = \frac{P_1 r_1^4}{P_1 r_2^4}$

$\Rightarrow \frac{Q}{2Q} = \frac{pr^4}{P_2(2r)^4}$

$\Rightarrow P_2 = \frac{P}{8}$