Ordinary Thinking

Objective Questions

Pressure and Density

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

[RPET 2000]

(a) 10 *m* (b) 20 *m*

(c) 60 *m* (d) 30 *m*

2. Two bodies are in equilibrium when suspended in water from the arms of a balance. The mass of one body is 36 *g* and its density is 9 *g / cm*. If the mass of the other is 48 *g*, its density in *g / cm* is

(a) $\frac{4}{3}$ (b) $\frac{3}{2}$

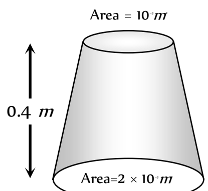
(c) 3 (d) 5

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

(a) 350 *cm* (b) 300 *cm*

(c) 250 *cm* (d) 22 *cm*

4. A uniformly tapering vessel is filled with a liquid of density 900 *kg/m*. The force that acts on the base of the vessel due to the liquid is $(g = 10\,ms^{-2})$



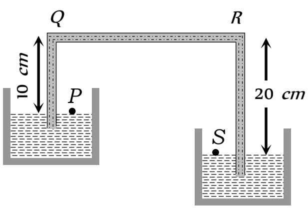
(a) 3.6 *N*

(b) 7.2 *N*

(c) 9.0 *N*

(d) 14.4 *N*

5. 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 *N/m*

(b) 2 × 10 *N/m*

(c) Zero

(d) Infinity

6. The height of a mercury barometer is 75 *cm* at sea level and 50 *cm* at the top of a hill. Ratio of density of mercury to that of air is 10. The height of the hill is

(a) 250 *m* (b) 2.5 *km*

(c) 1.25 *km* (d) 750 *m*

7. Density of ice is ρ and that of water is σ. What will be the decrease in volume when a mass *M* of ice melts

(a) $\frac{M}{\sigma - \rho}$ (b) $\frac{\sigma - \rho}{M}$

(c) $M\left[\frac{1}{\rho} - \frac{1}{\sigma}\right]$ (d) $\frac{1}{M}\left[\frac{1}{\rho} - \frac{1}{\sigma}\right]$

8. Equal masses of water and a liquid of density 2 are mixed together, then the mixture has a density of

(a) 2/3 (b) 4/3

(c) 3/2 (d) 3

9. A body of density d_1 is counterpoised by Mg of weights of density d_2 in air of density *d*. Then the true mass of the body is

(a) M (b) $M\left(1 - \frac{d}{d_2}\right)$

(c) $M\left(1 - \frac{d}{d_1}\right)$ (d) $\frac{M(1 - d/d_2)}{(1 - d/d_1)}$

10. The pressure at the bottom of a tank containing a liquid does not depend on **[Kerala (Engg.) 2002]**

(a) Acceleration due to gravity **[CBSE PMT 1994]**

(b) Height of the liquid column

(c) Area of the bottom surface

(d) Nature of the liquid

11. When a large bubble rises from the bottom of a lake to the surface. Its radius doubles. If atmospheric pressure is equal to that of column of water height *H*, then the depth of lake is

[AIIMS 1995; AFMC 1997]

[CPMT 1989]

(a) H (b) $2H$

(c) $7H$ (d) $8H$

12. The volume of an air bubble becomes three times as it rises from the bottom of a lake to its surface. Assuming atmospheric pressure to be 75 *cm* of *Hg* and the density of water to be 1/10 of the density of mercury, the depth of the lake is

(a) 5 *m* (b) 10 *m*

(c) 15 *m* (d) 20 *m*

13. The value of *g* at a place decreases by 2%. The barometric height of mercury

(a) Increases by 2%

(b) Decreases by 2%

(c) Remains unchanged

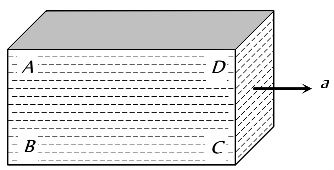
(d) Sometimes increases and sometimes decreases

14. A barometer kept in a stationary elevator reads 76 *cm*. If the elevator starts accelerating up the reading will be

(a) Zero (b) Equal to 76 *cm*

(c) More than 76 *cm* (d) Less than 76 *cm*

15. A closed rectangular tank is completely filled with water and is accelerated horizontally with an acceleration *a* towards right. Pressure is (i) maximum at, and (ii) minimum at



(a) (i) B (ii) D

(b) (i) C (ii) D

(c) (i) B (ii) C

(d) (i) *B* (ii) *A*

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

(a) Increases

(b) Decreases

(c) Remain constant

(d) First decrease and then increase

17. A barometer tube reads 76 *cm* of mercury. If the tube is gradually inclined at an angle of 60° with vertical, keeping the open end immersed in the mercury reservoir, the length of the mercury column will be

(a) 152 *cm* (b) 76 *cm*

(c) 38 *cm* (d) $38\sqrt{3}cm$

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

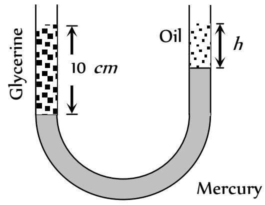
(a) Half of the radius of the vessel

(b) Radius of the vessel

(c) One-fourth of the radius of the vessel

(d) Three-fourth of the radius of the vessel

19. A vertical U-tube of uniform inner cross section contains mercury in both sides of its arms. A glycerin (density = 1.3 *g/cm*) column of length 10 *cm* is introduced into one of its arms. Oil of density 0.8 *gm/cm* is poured into the other arm until the upper surfaces of the oil and glycerin are in the same horizontal level. Find the length of the oil column, Density of mercury = 13.6 *g/cm*



(a) 10.4 cm

(b) 8.2 cm

(c) 7.2 cm

(d) 9.6 cm

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

(a) $\frac{1}{2}A\rho gh$ (b) $\frac{1}{3}A\rho gh$

(c) $\frac{1}{6}A\rho gh$ (d) $\frac{2}{3}A\rho gh$

21. If two liquids of same masses but densities ρ_1 and ρ_2 respectively are mixed, then density of mixture is given by

(a) $\rho = \frac{\rho_1 + \rho_2}{2}$ (b) $\rho = \frac{\rho_1 + \rho_2}{2\rho_1\rho_2}$

(c) $\rho = \frac{2\rho_1\rho_2}{\rho_1 + \rho_2}$ (d) $\rho = \frac{\rho_1\rho_2}{\rho_1 + \rho_2}$

22. If two liquids of same volume but different densities ρ_1 and ρ_2 are mixed, then density of mixture is given by

(a) $\rho = \frac{\rho_1 + \rho_2}{2}$ (b) $\rho = \frac{\rho_1 + \rho_2}{2\rho_1\rho_2}$

(c) $\rho = \frac{2\rho_1\rho_2}{\rho_1 + \rho_2}$ (d) $\rho = \frac{\rho_1\rho_2}{\rho_1 + \rho_2}$

23. The density ρ of water of bulk modulus B at a depth y in the ocean is related to the density at surface ρ_0 by the relation

(a) $\rho = \rho_0\left[1 - \frac{\rho_0 gy}{B}\right]$ (b) $\rho = \rho_0\left[1 + \frac{\rho_0 gy}{B}\right]$

(c) $\rho = \rho_0\left[1 + \frac{B}{\rho_0 hgy}\right]$ (d) $\rho = \rho_0\left[1 - \frac{B}{\rho_0 gy}\right]$

24. With rise in temperature, density of a given body changes according to one of the following relations

(a) $\rho = \rho_0[1 + \gamma\, d\theta]$ (b) $\rho = \rho_0[1 - \gamma\, d\theta]$

(c) $\rho = \rho_0 \gamma d\theta$ (d) $\rho = \rho_0 / \gamma d\theta$

25. Three liquids of densities $d, 2d$ and $3d$ are mixed in equal volumes. Then the density of the mixture is

(a) d (b) $2d$

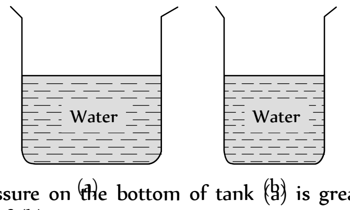
(c) $3d$ (d) $5d$

26. Three liquids of densities $d, 2d$ and $3d$ are mixed in equal proportions of weights. The relative density of the mixture is

(a) $\frac{11d}{7}$ (b) $\frac{18d}{11}$

(c) $\frac{13d}{9}$ (d) $\frac{23d}{18}$

27. From the adjacent figure, the correct observation is **[KCET 2005]**



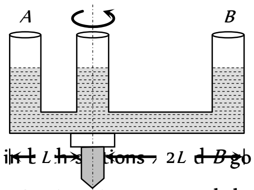
(a) The pressure on the bottom of tank (a) is greater than at the bottom of (b).

(b) The pressure on the bottom of the tank (a) is smaller than at the bottom of (b)

(c) The pressure depend on the shape of the container

(d) The pressure on the bottom of (a) and (b) is the same

28. A given shaped glass tube having uniform cross section is filled with water and is mounted on a rotatable shaft as shown in figure. If the tube is rotated with a constant angular velocity ω then



(a) Water levels in both sections A and B go up

(b) Water level in Section A goes up and that in B comes down

(c) Water level in Section A comes down and that in B it goes up

(d) Water levels remains same in both sections

29. Why the dam of water reservoir is thick at the bottom **[AFMC 2005]**

(a) Quantity of water increases with depth

(b) Density of water increases with depth

(c) Pressure of water increases with depth

(d) Temperature of water increases with depth

30. Air is blown through a hole on a closed pipe containing liquid. Then the pressure will **[AFMC 2005]**

(a) Increase on sides

(b) Increase downwards

(c) Increase in all directions

(d) Never increases

31. Radius of an air bubble at the bottom of the lake is r and it becomes $2r$ when the air bubbles rises to the top surface of the lake. If P *cm* of water be the atmospheric pressure, then the depth of the lake is

(a) $2p$ (b) $8p$

(c) $4p$ (d) $7p$

Pascal's Law and Archmidies Principle

1. An ice berg of density 900 *Kg/m* is floating in water of density 1000 *Kg/m*. The percentage of volume of ice-cube outside the water is

(a) 20% (b) 35%

(c) 10% (d) 25%

2. A log of wood of mass 120 *Kg* floats in water. The weight that can be put on the raft to make it just sink, should be (density of wood = 600 *Kg/m*) [CPMT 2004]

(a) 80 *Kg* (b) 50 *Kg*

(c) 60 *Kg* (d) 30 *Kg*

3. A hemispherical bowl just floats without sinking in a liquid of density 1.2×10 *kg/m*. If outer diameter and the density of the bowl are 1 *m* and 2×10 *kg/m* respectively, then the inner diameter of the bowl will be [SCRA 1998]

(a) 0.94 *m* (b) 0.97 *m*

(c) 0.98 *m* (d) 0.99 *m*

4. In making an alloy, a substance of specific gravity s_1 and mass m_1 is mixed with another substance of specific gravity s_2 and mass m_2; then the specific gravity of the alloy is [CPMT 1995]

(a) $\left(\dfrac{m_1+m_2}{s_1+s_2}\right)$ (b) $\left(\dfrac{s_1 s_2}{m_1+m_2}\right)$

(c) $\dfrac{m_1+m_2}{\left(\dfrac{m_1}{s_1}+\dfrac{m_2}{s_2}\right)}$ (d) $\dfrac{\left(\dfrac{m_1}{s_1}+\dfrac{m_2}{s_2}\right)}{m_1+m_2}$

5. A concrete sphere of radius R has a cavity of radius r which is packed with sawdust. The specific gravities of concrete and sawdust are respectively 2.4 and 0.3 for this sphere to float with its entire volume submerged under water. Ratio of mass of concrete to mass of sawdust will be [AIIMS 1995]

(a) 8 (b) 4

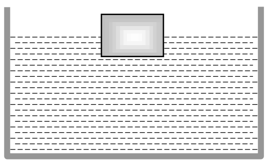
(c) 3 (d) Zero

6. A metallic block of density 5 *gm* cm and having dimensions 5 *cm* × 5 *cm* × 5 *cm* is weighed in water. Its apparent weight will be

(a) 5 × 5 × 5 × 5 *gf* (b) 4 × 4 × 4 × 4 gf

(c) 5 × 4 × 4 × 4 gf (d) 4 × 5 × 5 × 5 gf

7. A cubical block is floating in a liquid with half of its volume immersed in the liquid. When the whole system accelerates upwards with acceleration of *g/3*, the fraction of volume immersed in the liquid will be



(a) $\dfrac{1}{2}$

(b) $\dfrac{3}{8}$ [Kerla PET 2005]

(c) $\dfrac{2}{3}$

(d) $\dfrac{3}{4}$

8. A silver ingot weighing 2.1 *kg* is held by a string so as to be completely immersed in a liquid of relative density 0.8. The relative density of silver is 10.5. The tension in the string in *kg-wt* is [CPMT 2004]

(a) 1.6 (b) 1.94

(c) 3.1 (d) 5.25

9. A sample of metal weighs 210 *gm* in air, 180 *gm* in water and 120 *gm* in liquid. Then relative density (RD) of

(a) Metal is 3 (b) Metal is 7

(c) Liquid is 3 (d) Liquid is $\dfrac{1}{3}$

10. Two solids A and B float in water. It is observed that A floats with half its volume immersed and B floats with 2/3 of its volume immersed. Compare the densities of A and B

(a) 4 : 3 (b) 2 : 3

(c) 3 : 4 (d) 1 : 3

11. The fraction of a floating object of volume V_0 and density d_0 above the surface of a liquid of density d will be

(a) $\dfrac{d_0}{d}$ (b) $\dfrac{dd_0}{d+d_0}$

(c) $\dfrac{d-d_0}{d}$ (d) $\dfrac{dd_0}{d-d_0}$

12. 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

(a) Bernoulli (b) Archimedes

(c) Boyle (d) Pascal

13. A block of steel of size 5 *cm* × 5 *cm* × 5 *cm* is weighed in water. If the relative density of steel is 7, its apparent weight is

(a) 6 × 5 × 5 × 5 *gf* (b) 4 × 4 × 4 × 7 *gf*

(c) 5 × 5 × 5 × 7 *gf* (d) 4 × 4 × 4 × 6 *gf*

14. A body is just floating on the surface of a liquid. The density of the body is same as that of the liquid. The body is slightly pushed down. What will happen to the body [AIIMS 1980]

(a) It will slowly come back to its earlier position

(b) It will remain submerged, where it is left

(c) It will sink

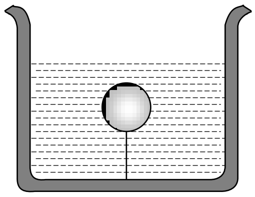
(d) It will come out violently

15. A cork is submerged in water by a spring attached to the bottom of a bowl. When the bowl is kept in an elevator moving with acceleration downwards, the length of spring

(a) Increases (b) Decreases

(c) Remains unchanged (d) None of these

16. A solid sphere of density η (> 1) times lighter than water is suspended in a water tank by a string tied to its base as shown in fig. If the mass of the sphere is m then the tension in the string is given by



(a) $\left(\frac{\eta-1}{\eta}\right)mg$

(b) ηmg

(c) $\frac{mg}{\eta-1}$

(d) $(\eta-1)mg$

17. A hollow sphere of volume V is floating on water surface with *half* immersed in it. What should be the minimum volume of water poured inside the sphere so that the sphere now sinks into the water

(a) $V/2$ (b) $V/3$

(c) $V/4$ (d) V

18. A rectangular block is 5 *cm* × 5 *cm* × 10*cm* in size. The block is floating in water with 5 *cm* side vertical. If it floats with 10 *cm* side vertical, what change will occur in the level of water?

(a) No change

(b) It will rise

(c) It will fall

(d) It may rise or fall depending on the density of block

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

(a) 9 *cm* (b) 6 *cm*

(c) 4.5 *cm* (d) 2.25 *cm*

20. Two solids A and B float in water. It is observed that A floats with $\frac{1}{2}$ of its body immersed in water and B floats with $\frac{1}{4}$ of its volume above the water level. The ratio of the density of A to that of B is

(a) 4 : 3 (b) 2 : 3

(c) 3 : 4 (d) 1 : 2

21. A boat carrying steel balls is floating on the surface of water in a tank. If the balls are thrown into the tank one by one, how will it affect the level of water **[J&K CET 2005]**

(a) It will remain unchanged

(b) It will rise

(c) It will fall

(d) First it will first rise and then fall

22. Two pieces of metal when immersed in a liquid have equal upthrust on them; then

(a) Both pieces must have equal weights

(b) Both pieces must have equal densities

(c) Both pieces must have equal volumes

(d) Both are floating to the same depth

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

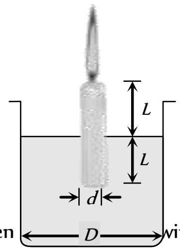
(a) Equal of that of water

(b) Half the density of water

(c) Double the density of water

(d) The question is incomplete

24. A candle of diameter d is floating on a liquid in a cylindrical container of diameter D (D>>d) as shown in figure. If it is burning at the rate of 2*cm/hour* then the top of the candle will



(a) Remain at the same height

(b) Fall at the rate of 1 *cm/hour*

(c) Fall at the rate of 2 *cm/hour*

(d) Go up the rate of 1*cm/hour*

25. An ice block contains a glass ball when within the water containing vessel, the level of water **[AFMC 2005]**

(a) Rises (b) Falls

(c) Unchanged (d) First rises and then falls

26. A large ship can float but a steel needle sinks because of **[AFMC 2005]**

(a) Viscosity (b) Surface tension

(c) Density (d) None of these

27. Construction of submarines is based on **[Kerala PMT 2005]**

(a) Archimedes' principle (b) Bernoulli's theorem

(c) Pascal's law (d) Newton's laws

Fluid Flow

1. In which one of the following cases will the liquid flow in a pipe be most streamlined **[Pb. CET 2005]**

(a) Liquid of high viscosity and high density flowing through a pipe of small radius

(b) Liquid of high viscosity and low density flowing through a pipe of small radius

(c) Liquid of low viscosity and low density flowing through a pipe of large radius

(d) Liquid of low viscosity and high density flowing through a pipe of large radius

2. Two water pipes of diameters 2 *cm* and 4 *cm* are connected with the main supply line. The velocity of flow of water in the pipe of 2 *cm* diameter is **[MNR 1980]**

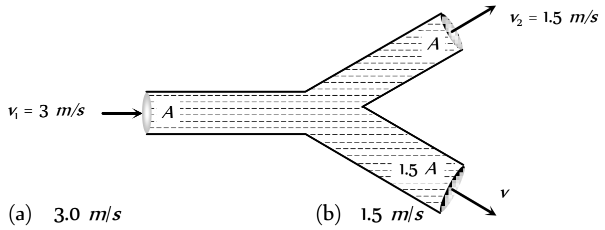
(a) 4 times that in the other pipe

(b) $\frac{1}{4}$ times that in the other pipe

(c) 2 times that in the other pipe

(d) $\frac{1}{2}$ times that in the other pipe

3. An incompressible liquid flows through a horizontal tube as shown in the following fig. Then the velocity v of the fluid is



(a) 3.0 m/s (b) 1.5 m/s
(c) 1.0 m/s (d) 2.25 m/s

4. Water enters through end A with speed v_1 and leaves through end B with speed v_2 of a cylindrical tube AB. The tube is always completely filled with water. In case I tube is horizontal and in case II it is vertical with end A upwards and in case III it is vertical with end B upwards. We have $v_1 = v_2$ for

(a) Case I (b) Case II
(c) Case III (d) Each case

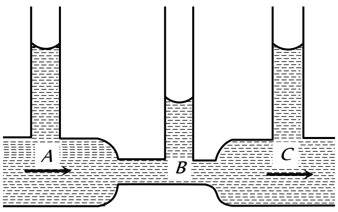
5. Water is moving with a speed of 5.18 *ms* through a pipe with a cross-sectional area of 4.20 *cm*. The water gradually descends 9.66 *m* as the pipe increase in area to 7.60 *cm*. The speed of flow at the lower level is

(a) 3.0 *ms* (b) 5.7 *ms*
(c) 3.82 *ms* (d) 2.86 *ms*

6. The velocity of kerosene oil in a horizontal pipe is 5 m/s. If $g = 10 m/s^2$ then the velocity head of oil will be

(a) 1.25 m (b) 12.5 m
(c) 0.125 m (d) 125 m

7. 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 maximum
(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

8. A manometer connected to a closed tap reads 3.5 × 10 *N/m*. When the valve is opened, the reading of manometer falls to 3.0 × 10 *N/m*, 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

9. Air is streaming past a horizontal air plane wing such that its speed in 120 *m/s* over the upper surface and 90 *m/s* at the lower surface. If the density of air is 1.3 *kg* per metre and the wing is 10 *m* long and has an average width of 2 *m*, then the difference of the pressure on the two sides of the wing of

(a) 4095.0 *Pascal* (b) 409.50 *Pascal*
(c) 40.950 *Pascal* (d) 4.0950 *Pascal*

10. A large tank filled with water to a height 'h' is to be emptied through a small hole at the bottom. The ratio of time taken for the level of water to fall from h to $\frac{h}{2}$ and from $\frac{h}{2}$ to zero is

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

11. A cylinder of height 20 *m* is completely filled with water. The velocity of efflux of water (in *m/s*) through a small hole on the side wall of the cylinder near its bottom is **[AIEEE 2002]**

(a) 10 (b) 20
(c) 25.5 (d) 5

12. There is a hole in the bottom of tank having water. If total pressure at bottom is 3 *atm* (1 *atm* = 10 *N/m*) then the velocity of water flowing from hole is **[CPMT 2002]**

(a) $\sqrt{400}\ m/s$ (b) $\sqrt{600}\ m/s$
(c) $\sqrt{60}\ m/s$ (d) None of these

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) $t/4$

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

(a) 2.5 *cm* (b) 5 *cm*
(c) 10 *cm* (d) 0.25 *cm*

15. A square plate of 0.1 *m* side moves parallel to a second plate with a velocity of 0.1 *m/s*, both plates being immersed in water. If the viscous force is 0.002 *N* and the coefficient of viscosity is 0.01 *poise*, distance between the plates in *m* is **[EAMCET (Med.) 2003]**

(a) 0.1 (b) 0.05
(c) 0.005 (d) 0.0005

16. 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 **[AIEEE 2004]**

(a) Inversely proportional to 'r' but directly proportional to velocity 'v'
(b) Directly proportional to both radius 'r' and velocity 'v'
(c) Inversely proportional to both radius 'r' and velocity 'v'
(d) Directly proportional to 'r' but inversely proportional to 'v'

17. A small sphere of mass *m* is dropped from a great height. After it has fallen 100 *m*, it has attained its terminal velocity and continues to fall at that speed. The work done by air friction against the sphere during the first 100 *m* of fall is **[MP PMT 1990]**

(a) Greater than the work done by air friction in the second 100 *m*

(b) Less than the work done by air friction in the second 100 *m*

(c) Equal to 100 *mg*

(d) Greater than 100 *mg*

18. Two drops of the same radius are falling through air with a steady velocity of 5 *cm* per *sec*. If the two drops coalesce, the terminal velocity would be [MP PMT 1990]

(a) 10 *cm* per *sec* (b) 2.5 *cm* per *sec*

(c) $5 \times (4)^{1/3}\ cm$ per *sec* (d) $5 \times \sqrt{2}\ cm$ per sec

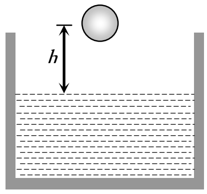
19. A ball of radius *r* and density ρ falls freely under gravity through a distance *h* before entering water. Velocity of ball does not change even on entering water. If viscosity of water is η, the value of *h* is given by

(a) $\frac{2}{9} r^2 \left(\frac{1-\rho}{\eta}\right) g$

(b) $\frac{2}{81} r^2 \left(\frac{\rho-1}{\eta}\right) g$

(c) $\frac{2}{81} r^4 \left(\frac{\rho-1}{\eta}\right)^2 g$

(d) $\frac{2}{9} r^4 \left(\frac{\rho-1}{\eta}\right)^2 g$



20. The rate of steady volume flow of water through a capillary tube of length '*l*' and radius '*r*' under a pressure difference of *P* is *V*. This tube is connected with another tube of the same length but half the radius in series. Then the rate of steady volume flow through them is (The pressure difference across the combination is *P*)

(a) $\frac{V}{16}$ (b) $\frac{V}{17}$

(c) $\frac{16V}{17}$ (d) $\frac{17V}{16}$

21. A liquid is flowing in a horizontal uniform capillary tube under a constant pressure difference *P*. The value of pressure for which the rate of flow of the liquid is doubled when the radius and length both are doubled is [EAMCET 2001]

(a) *P* (b) $\frac{3P}{4}$

(c) $\frac{P}{2}$ (d) $\frac{P}{4}$

22. We have two (narrow) capillary tubes T_1 and T_2. Their lengths are l_1 and l_2 and radii of cross-section are r_1 and r_2 respectively. The rate of flow of water under a pressure difference *P* through tube T_1 is 8*cm/sec*. If $l_2 = 2l_1$ and $r_2 = r_1$, what will be the rate of flow when the two tubes are connected in series and pressure difference across the combination is same as before (= *P*)

(a) 4 *cm/sec* (b) (16/3) *cm/sec*

(c) (8/17) *cm/sec* (d) None of these

23. In a laminar flow the velocity of the liquid in contact with the walls of the tube is

(a) Zero

(b) Maximum

(c) In between zero and maximum

(d) Equal to critical velocity

24. In a turbulent flow, the velocity of the liquid molecules in contact with the walls of the tube is

(a) Zero

(b) Maximum

(c) Equal to critical velocity

(d) May have any value

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

(a) Gravity to viscous force

(b) Gravity force to pressure force

(c) Inertia forces to viscous force

(d) Viscous forces to pressure forces

26. Water is flowing through a tube of non-uniform cross-section ratio of the radius at entry and exit end of the pipe is 3 : 2. Then the ratio of velocities at entry and exit of liquid is [RPMT 2001]

(a) 4 : 9 (b) 9 : 4

(c) 8 : 27 (d) 1 : 1

27. Water is flowing through a horizontal pipe of non-uniform cross-section. At the extreme narrow portion of the pipe, the water will have [MP PMT 1992]

(a) Maximum speed and least pressure

(b) Maximum pressure and least speed

(c) Both pressure and speed maximum

(d) Both pressure and speed least

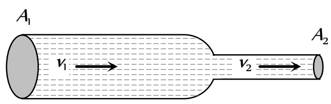
28. A liquid flows in a tube from left to right as shown in figure. A_1 and A_2 are the cross-sections of the portions of the tube as shown. Then the ratio of speeds v_1 / v_2 will be [EAMCET (Engg.) 2003]

(a) A_1 / A_2

(b) A_2 / A_1

(c) $\sqrt{A_2} / \sqrt{A_1}$

(d) $\sqrt{A_1} / \sqrt{A_2}$



29. In a streamline flow

(a) The speed of a particle always remains same

(b) The velocity of a particle always remains same

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

(d) The moments of all the particles arriving at a given point are the same

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

(a) Dynamic lift of an aeroplane

(b) Viscosity meter

(c) Capillary rise

(d) Hydraulic press

31. The Working of an atomizer depends upon

[MP PMT 1992; AFMC 2005]

(a) Bernoulli's theorem (b) Boyle's law

(c) Archimedes principle (d) Newton's law of motion

32. The pans of a physical balance are in equilibrium. Air is blown under the right hand pan; then the right hand pan will

(a) Move up

(b) Move down

(c) Move erratically

(d) Remain at the same level

33. According to Bernoulli's equation

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

The terms *A*, *B* and *C* are generally called respectively:

(a) Gravitational head, pressure head and velocity head

(b) Gravity, gravitational head and velocity head

(c) Pressure head, gravitational head and velocity head

(d) Gravity, pressure and velocity head

34. At what speed the velocity head of a stream of water be equal to 40 *cm* of *Hg*

(a) 282.8 *cm/sec* (b) 432.6 *cm/sec*

(c) 632.6 *cm/sec* (d) 832.6 *cm/sec*

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

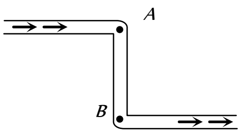
(a) Upthrust of the air which will be equal to the weight of the air having the same volume as the plane

(b) Force due to the pressure difference between the upper and lower surfaces of the wings, created by different air speeds on the surface

(c) Vertical component of the thrust created by air currents striking the lower surface of the wings

(d) Force due to the reaction of gases ejected by the revolving propeller

36. In this figure, an ideal liquid flows through the tube, 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



(a) $v_A = v_B$

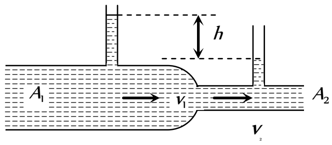
(b) $v_B > v_A$

(c) $P_A = P_B$

(d) $P_A > P_B$

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

(a) The volume of the liquid flowing through the tube in unit time is A_1v_1



(b) $v_2 - v_1 = \sqrt{2gh}$

(c) $v_2^2 - v_1^2 = 2gh$

(d) The energy per unit mass of the liquid is the same in both sections of the tube

38. 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

(a) $27.8\,ms^{-1}$ (b) $41.0\,ms^{-1}$

(c) $9.6\,ms^{-1}$ (d) $19.7\,ms^{-1}$

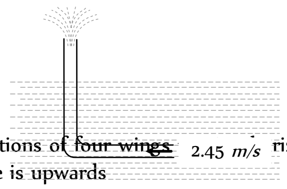
39. An L-shaped tube with a small orifice is held in a water stream as shown in fig. The upper end of the tube is 10.6 *cm* above the surface of water. What will be the height of the jet of water coming from the orifice? Velocity of water stream is 2.45 *m/s*

(a) Zero

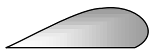
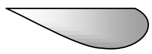
(b) 20.0 *cm*

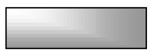
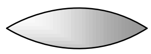
(c) 10.6 *cm*

(d) 40.0 *cm*

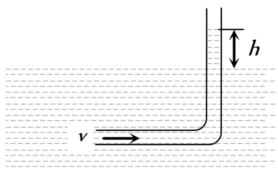


40. Fig. represents vertical sections of four wings rizontally in air. In which case the force is upwards

(a)  (b) 

(c)  (d) 

41. 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



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

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

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

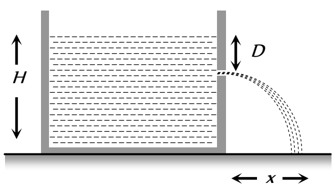
(d) None of these

42. 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* [MNR 1992; CPMT 2004]

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

(b) $x = \sqrt{\frac{D(H-D)}{2}}$

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

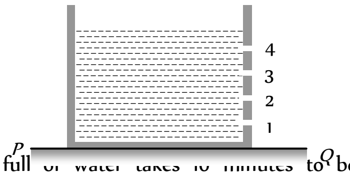


(d) $x = 4\sqrt{D(H-D)}$

43. A cylindrical vessel of 90 *cm* height is kept filled upto the brim. It has four holes 1, 2, 3, 4 which are respectively at heights of 20 *cm*, 30 *cm*, 45 *cm* and 50 *cm* from the horizontal floor *PQ*. The water falling at the maximum horizontal distance from the vessel comes from

[CPMT 1989]

(a) Hole number 4
(b) Hole number 3
(c) Hole number 2
(d) Hole number 1



44. A rectangular vessel when full of water takes 10 minutes to be emptied through an orifice in its bottom. How much time will it take to be emptied when half filled with water

(a) 9 *minute* (b) 7 *minute*
(c) 5 *minute* (d) 3 *minute*

45. A streamlined body falls through air from a height h on the surface of a liquid. If d and $D(D > d)$ represents the densities of the material of the body and liquid respectively, then the time after which the body will be instantaneously at rest, is

(a) $\sqrt{\frac{2h}{g}}$ (b) $\sqrt{\frac{2h}{g}\cdot\frac{D}{d}}$

(c) $\sqrt{\frac{2h}{g}\cdot\frac{d}{D}}$ (d) $\sqrt{\frac{2h}{g}}\left(\frac{d}{D-d}\right)$

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

(a) 2 (b) 3
(c) 4 (d) $2\sqrt{2}$

47. Velocity of water in a river is [CBSE PMT 1988]

(a) Same everywhere
(b) More in the middle and less near its banks
(c) Less in the middle and more near its banks
(d) Increase from one bank to other bank

48. As the temperature of water increases, its viscosity

(a) Remains unchanged
(b) Decreases
(c) Increases
(d) Increases or decreases depending on the external pressure

49. The coefficient of viscosity for hot air is

(a) Greater than the coefficient of viscosity for cold air
(b) Smaller than the coefficient of viscosity for cold air
(c) Same as the coefficient of viscosity for cold air
(d) Increases or decreases depending on the external pressure

50. A good lubricant should have

(a) High viscosity (b) Low viscosity
(c) Moderate viscosity (d) High density

51. We have three beakers *A*, *B* and *C* containing glycerine, water and kerosene respectively. They are stirred vigorously and placed on a table. The liquid which comes to rest at the earliest is

(a) Glycerine
(b) Water
(c) Kerosene
(d) All of them at the same time

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

(a) $\propto \sqrt{h}$
(b) $\propto h$
(c) $\propto (1/h)$
(d) Almost independent of h

53. The rate of flow of liquid in a tube of radius *r*, length *l*, whose ends are maintained at a pressure difference P is $V = \frac{\pi Q P r^4}{\eta l}$ where η is coefficient of the viscosity and Q is

[DCE 2002]

(a) 8 (b) $\frac{1}{8}$
(c) 16 (d) $\frac{1}{16}$

54. In Poiseuilli's method of determination of coefficient of viscosity, the physical quantity that requires greater accuracy in measurement is

(a) Pressure difference
(b) Volume of the liquid collected
(c) Length of the capillary tube
(d) Inner radius of the capillary tube

55. Two capillary tubes of the same length but different radii r_1 and r_2 are fitted in parallel to the bottom of a vessel. The pressure head is *P*. What should be the radius of a single tube that can replace the two tubes so that the rate of flow is same as before

(a) $r_1 + r_2$ (b) $r_1^2 + r_2^2$
(c) $r_1^4 + r_2^4$ (d) None of these

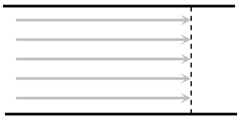
56. Two capillaries of same length and radii in the ratio 1 : 2 are connected in series. A liquid flows through them in streamlined condition. If the pressure across the two extreme ends of the combination is 1 *m* of water, the pressure difference across first capillary is

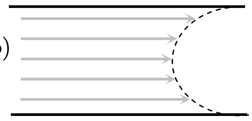
(a) 9.4 *m* (b) 4.9 *m*
(c) 0.49 *m* (d) 0.94 *m*

57. 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 2*P*, the rate of flow becomes

(a) $4Q$ (b) Q
(c) $\frac{Q}{4}$ (d) $\frac{Q}{8}$

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

(a) 

(b) 

(c) 

(d) None of these

59. Water is flowing in a pipe of diameter 4 *cm* with a velocity 3 *m/s*. The water then enters into a tube of diameter 2 *cm*. The velocity of water in the other pipe is [BCECE 2005]

(a) 3 *m/s* (b) 6 *m/s*

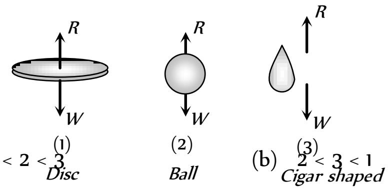
(c) 12 *m/s* (d) 8 *m/s*

60. Two capillary of length L and $2L$ and of radius R and $2R$ are connected in series. The net rate of flow of fluid through them will be (given rate of the flow through single capillary, $X = \pi PR^4 / 8\eta L$) [DCE 2005]

(a) $\frac{8}{9}X$ (b) $\frac{9}{8}X$

(c) $\frac{5}{7}X$ (d) $\frac{7}{5}X$

61. When a body falls in air, the resistance of air depends to a great extent on the shape of the body, 3 different shapes are given. Identify the combination of air resistances which truly represents the physical situation. (The cross sectional areas are the same).



(a) 1 < 2 < 3 (b) 2 < 3 < 1

(c) 3 < 2 < 1 (d) 3 < 1 < 2

62. Water falls from a tap, down the streamline [Orissa JEE 2005]

(a) Area decreases (b) Area increases

(c) Velocity remains same (d) Area remains same

63. A manometer connected to a closed tap reads 4.5×10^5 *pascal*. When the tap is opened the reading of the manometer falls to 4×10^5 *pascal*. Then the velocity of flow of water is

(a) 7 ms^{-1} (b) 8 ms^{-1}

(c) 9 ms^{-1} (d) 10 ms^{-1}

64. What is the velocity v of a metallic ball of radius r falling in a tank of liquid at the instant when its acceleration is one-half that of a freely falling body ? (The densities of metal and of liquid are ρ and σ respectively, and the viscosity of the liquid is η).

(a) $\frac{r^2g}{9\eta}(\rho - 2\sigma)$ (b) $\frac{r^2g}{9\eta}(2\rho - \sigma)$

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

65. Consider the following equation of Bernouilli's theorem.

$P + \frac{1}{2}\rho V^2 + \rho gh = K$ (constant)

The dimensions of *K/P* are same as that of which of the following [AFMC 2005]

(a) Thrust (b) Pressure

(c) Angle (d) Viscosity

66. An incompressible fluid flows steadily through a cylindrical pipe which has radius $2r$ at point A and radius r at B further along the flow direction. If the velocity at point A is v, its velocity at point B is [Kerala PMT 2005]

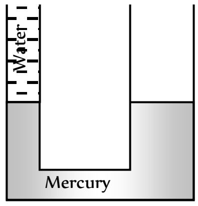
(a) $2v$ (b) v

(c) $v/2$ (d) $4v$

Critical Thinking

Objective Questions

1. A U-tube in which the cross-sectional area of the limb on the left is one quarter, the limb on the right contains mercury (density 13.6 *g/cm*). The level of mercury in the narrow limb is at a distance of 36 *cm* from the upper end of the tube. What will be the rise in the level of mercury in the right limb if the left limb is filled to the top with water



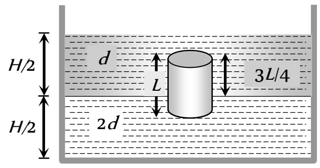
(a) 1.2 *cm*

(b) 2.35 *cm*

(c) 0.56 *cm* [KCET 2005]

(d) 0.8 *cm*

2. A homogeneous solid cylinder of length $L(L < H/2)$. Cross-sectional area $A/5$ is immersed such that it floats with its axis vertical at the liquid-liquid interface with length $L/4$ in the denser liquid as shown in the fig. The lower density liquid is open to atmosphere having pressure P_0. Then density D of solid is given by



(a) $\frac{5}{4}d$

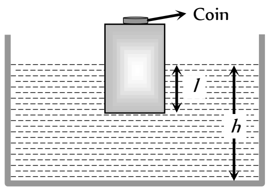
(b) $\frac{4}{5}d$

(c) d

(d) $\frac{d}{5}$

3. A wooden block, with a coin placed on its top, floats in water as shown in fig. the distance l and h are shown there. After some time the coin falls into the water. Then [Kerala PET 2005]

[IIT-JEE (Screening) 2002]



(a) l decreases and h increases

(b) l increases and h decreases

(c) Both l and h increase [Kerala PET 2005]

(d) Both l and h decrease

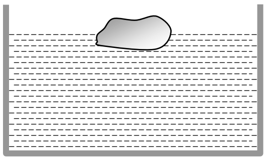
4. A vessel contains oil (density = 0.8 *gm/cm*) over mercury (density = 13.6 *gm/cm*). A homogeneous sphere floats with half of its volume immersed in mercury and the other half in oil. The density of the material of the sphere in *gm/cm* is

(a) 3.3 (b) 6.4

(c) 7.2 (d) 12.8

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

[IIT-JEE 1982]



(a) Zero

(b) Equal to the weight of the liquid displaced

(c) Equal to the weight of the body in air

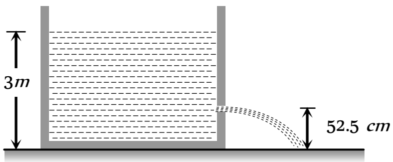
(d) Equal to the weight of the immersed position of the body

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

(a) $\frac{r\omega}{2g}$ (b) $\frac{r^2\omega^2}{2g}$

(c) $\sqrt{2gr\omega}$ (d) $\frac{\omega^2}{2gr^2}$

7. Water is filled in a cylindrical container to a height of 3*m*. The ratio of the cross-sectional area of the orifice and the beaker is 0.1. The square of the speed of the liquid coming out from the orifice is (g = 10 *m/s*) [IIT JEE 2004]



(a) 50 *m/s*

(b) 50.5 *m/s*

(c) 51 *m/s*

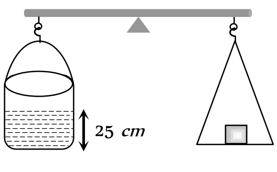
(d) 52 *m/s*

8. A large open tank has two holes in the wall. One is a square hole of side L at a depth y from the top and the other is a circular hole of radius R at a depth $4y$ from the top. When the tank is completely filled with water the quantities of water flowing out per second from both the holes are the same. Then R is equal to

(a) $2\pi L$ (b) $\frac{L}{\sqrt{2\pi}}$

(c) L (d) $\frac{L}{2\pi}$

9. A cylinder containing water up to a height of 25 *cm* has a hole of cross-section $\frac{1}{4}cm^2$ in its bottom. It is counterpoised in a balance. What is the initial change in the balancing weight when water begins to flow out



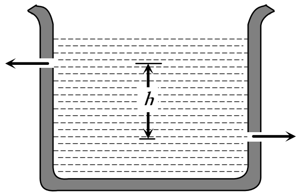
(a) Increase of 12.5 *gm-wt*

(b) Increase of 6.25 *gm-wt*

(c) Decrease of 12.5 *gm-wt*

(d) Decrease of 6.25 *gm-wt*

10. There are two identical small holes of area of cross-section a on the opposite sides of a tank containing a liquid of density ρ. The difference in height between the holes is h. Tank is resting on a smooth horizontal surface. Horizontal force which will has to be applied on the tank to keep it in equilibrium is



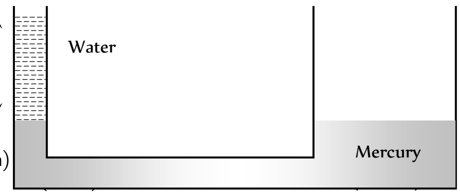
(a) $gh\rho a$

(b) $\frac{2gh}{\rho a}$

(c) $2\rho agh$

(d) $\frac{\rho gh}{a}$

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



(a)

(c) $\frac{h}{(n+1)^2 s}$ (d) $\frac{h}{n^2 s}$

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

(a) $\sin\theta = \frac{1}{2}\sqrt{\rho_0/\rho}$ (b) $\sin\theta = \frac{1}{2}.\frac{\rho_0}{\rho}$

(c) $\sin\theta = \sqrt{\rho/\rho_0}$ (d) $\sin\theta = \rho_0/\rho$

[IIT-JEE (Screening) 2000]

13. A block of ice floats on a liquid of density 1.2in a beaker then level of liquid when ice completely melt

[IIT-JEE 1994]

(a) Remains same (b) Rises

(c) Lowers (d) (a), (b) or (c)

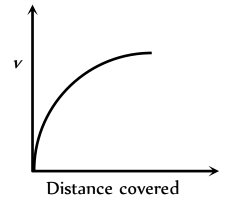
14. A vessel of area of cross-section A has liquid to a height H. There is a hole at the bottom of vessel having area of cross-section a. The time taken to decrease the level from H_1 to H_2 will be

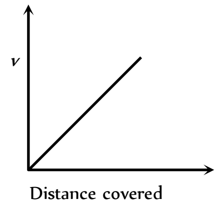
(a) $\frac{A}{a}\sqrt{\frac{2}{g}}[\sqrt{H_1} - \sqrt{H_2}]$ (b) $\sqrt{2gh}$

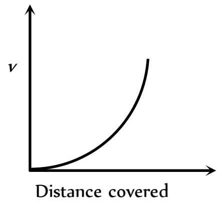
(c) $\sqrt{2gh(H_1 - H_2)}$ (d) $\frac{A}{a}\sqrt{\frac{g}{2}}[\sqrt{H_1} - \sqrt{H_2}]$

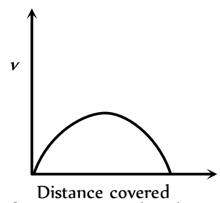
GQ Graphical Questions

1. A lead shot of 1mm diameter falls through a long column of glycerine. The variation of its velocity v. with distance covered is represented by [AIIMS 2003]

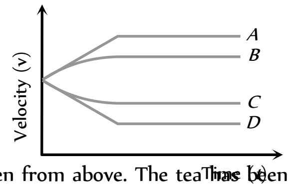
(a) 

(b) 

(c) 

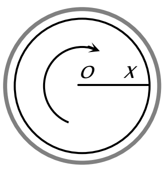
(d) 

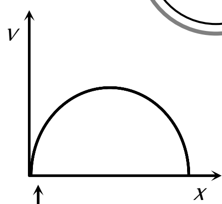
2. A small spherical solid ball is dropped from a great height in a viscous liquid. Its journey in the liquid is best described in the diagram given below by the [CPMT 1988]

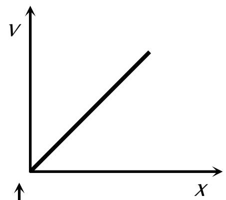


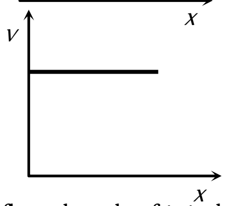
(a) Curve A
(b) Curve B
(c) Curve C
(d) Curve D

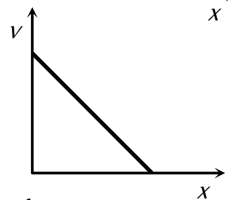
3. The diagram shows a cup of tea seen from above. The tea has been stirred and is now rotating without turbulence. A graph showing the speed v with which the liquid is crossing points at a distance X from O along a radius XO would look like



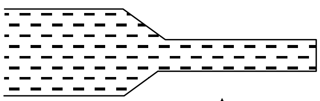
(a) 

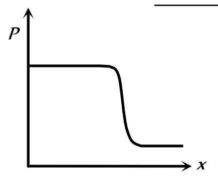
(b) 

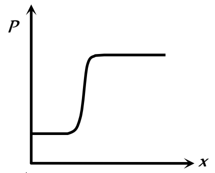
(c) 

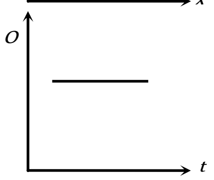
(d) 

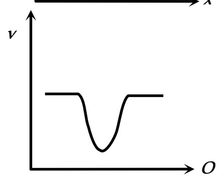
4. Water flows through a frictionless duct with a cross-section varying as shown in fig. Pressure p at points along the axis is represented by



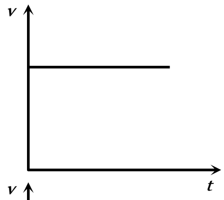
(a) 

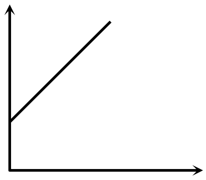
(b) 

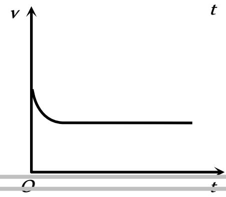
(c) 

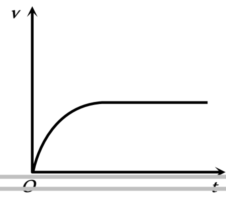
(d) 

5. From amongst the following curves, which one shows the variation of the velocity v with time t for a small sized spherical body falling vertically in a long column of a viscous liquid

(a) 

(b) 

(c) 

(d) 

AR Assertion & Reason

For AIIMS Aspirants

Read the assertion and reason carefully to mark the correct option out of the options given below:

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.
(c) If assertion is true but reason is false.
(d) If the assertion and reason both are false.
(e) If assertion is false but reason is true.

1. Assertion : Pascal law is the working principle of a hydraulic lift.
   Reason : Pressure is equal to thrust per area.
2. Assertion : The blood pressure in humans is greater at the feet than at the brain.
   Reason : Pressure of liquid at any point is proportional to height, density of liquid and acceleration due to gravity.
3. Assertion : Hydrostatic pressure is a vector quantity.
   Reason : Pressure is force divided by area, and force is a vector quantity.
4. Assertion : To float, a body must displace liquid whose weight is greater than the actual weight of the body.
   Reason : The body will experiences no net downward force, in the case of floating.
5. Assertion : A man sitting in a boat which is floating on a pond. If the man drinks some water from the pond, the level of the water in the pond decreases.
   Reason : According to Archimede's principle the weight displaced by body is equal to the weight of the body.
6. Assertion : A piece of ice floats in water, the level of water remains unchanged when the ice melts completely.
   Reason : According to Archimede's principle, the loss in weight of the body in the liquid is equal to the weight of the liquid displaced by the immersed part of the body.
7. Assertion : The velocity increases, when water flowing in broader pipe enter a narrow pipe.

Reason	:	According to equation of continuity, product of area and velocity is constant.

8. Assertion : The velocity of fall of a man jumping with a parachute first increases and then becomes constant.

Reason : The constant velocity of fall of man is called terminal velocity.

9. Assertion : The velocity of flow of a liquid is smaller when pressure is larger and viceversa.

Reason : According to Bernoulli's theorem, for the stream line flow of an ideal liquid, the total energy per unit mass remains constant.

10. Assertion : The shape of an automobile is so designed that its front resembles the stream line pattern of the fluid through which it moves.

Reason : The resistance offered by the fluid is maximum.

11. Assertion : The size of the needle of a syringe controls flow rate better than the thumb pressure exerted by a doctor while administering an injection.

Reason : Flow rate is independent of pressure exerted by the thumb of the doctor.

12. Assertion : A fluid flowing out of a small hole in a vessel apply a backward thrust on the vessel.

Reason : According to equation of continuity, the product of area and velocity remain constant.

13. Assertion : For a floating body to be in stable equilibrium, its centre of buoyancy must be located above the centre of gravity.

Reason : The torque produced by the weight of the body and the upthrust will restore body back to its normal position, after the body is disturbed.

14. Assertion : Water flows faster than honey.

Reason : The coefficient of viscosity of water is less than honey.

15. Assertion : The viscosity of liquid increases rapidly with rise of temperature.

Reason : Viscosity of a liquid is the property of the liquid by virtue of which it opposes the relative motion amongst its different layers.

16. Assertion : Aeroplanes are made to run on the runway before take off, so that they acquire the necessary lift.

Reason : According to Bernoulli's theorem, as velocity increases pressure decreases and viceversa.

17. Assertion : Sudden fall of pressure at a place indicates strom.

Reason : Air flows from higher pressure to lower pressure.

18. Assertion : Machine parts are jammed in winter.

Reason : The viscosity of lubricant used in machine parts increase at low temperature.

19. Assertion : A block of wood is floating in a tank containing water. The apparent weight of the floating block is equal to zero.

Reason : Because the entire weight of the block is supported by the buoyant force (the upward thrust) due to water.

20. Assertion : A rain drop after falling through some height attains a constant velocity.

Reason : At constant velocity, the viscous drag is just equal to its weight.

21. Assertion : paper pins are made to have pointed end.

Reason : Because pointed pins have very smalll area due to which even for small applied force it exert large pressure on the surface.

22. Assertion : Railways tracks are laid on small sized wooden sleepers.

Reason : Small sized wooden sleepers are used so that rails exert more pressure on the railway track. Due to which rail does not leave the track

23. Assertion : It is difficult to stop bleeding from a cut in the body at high altitudes.

Reason : The atmospheric pressure at high altitude is lesser than the blood pressure.

24. Assertion : To empty an oil tank, two holes are made.

Reason : Oil will come out two holes so it will emptied faster.

25. Assertion : Terminal velocity is same as the critical velocity.

Reason : The constant velocity of fall of a body through a viscous fluid is called terminal velocity.

26. Assertion : When two boats sails parallel in the same direction and close to each other, they are pulled towards each other.

Reason : The viscous drag on a spherical body moving with speed v is proportional to v.

27. Assertion : Cars and aeroplanes are streamlined.

Reason : This is done to reduce the backward drag due to atmosphere.

28. Assertion : Bernoulli's theorem holds for incompressible, non-viscous fluids.

Reason : The factor $\frac{v^2}{2g}$ is called velocity head.

Answers

Pressure and Density

1	b	2	c	3	b	4	b	5	c
6	b	7	c	8	b	9	d	10	c
11	c	12	c	13	a	14	d	15	a
16	b	17	a	18	b	19	d	20	b
21	c	22	a	23	b	24	b	25	b
26	b	27	d	28	a	29	c	30	c
31	d								

Pascal's Law and Archmidies Principle

1	c	2	a	3	c	4	c	5	b
6	d	7	a	8	b	9	bc	10	c
11	c	12	d	13	a	14	b	15	b
16	d	17	a	18	a	19	b	20	b
21	c	22	c	23	b	24	b	25	b
26	d	27	a						

Fluid Flow

1	b	2	a	3	c	4	d	5	d
6	a	7	d	8	b	9	a	10	c
11	b	12	a	13	c	14	a	15	d
16	b	17	b	18	c	19	c	20	b
21	d	22	b	23	a	24	d	25	c
26	a	27	a	28	b	29	a	30	a
31	a	32	b	33	c	34	a	35	b
36	ad	37	acd	38	b	39	b	40	a
41	a	42	c	43	b	44	b	45	d
46	c	47	b	48	b	49	a	50	a
51	a	52	d	53	b	54	d	55	d
56	d	57	d	58	c	59	c	60	a
61	c	62	a	63	d	64	c	65	c
66	d								

Critical Thinking Questions

1	c	2	a	3	d	4	c	5	a
6	b	7	a	8	b	9	c	10	c
11	b	12	a	13	b	14	a		

Graphical Questions

1	a	2	b	3	d	4	a	5	d

Assertion and Reason

1	b	2	a	3	e	4	c	5	e
6	a	7	a	8	b	9	a	10	c
11	c	12	a	13	a	14	a	15	e
16	a	17	a	18	a	19	a	20	a
21	a	22	d	23	a	24	c	25	e
26	b	27	a	28	b				

Answers and Solutions

Pressure and Density

1. (b) Pressure at bottom of the lake = $P_0 + h\rho g$

Pressure at half the depth of a lake $= P_0 + \frac{h}{2}\rho g$

According to given condition

$P_0 + \frac{1}{2}h\rho g = \frac{2}{3}(P_0 + h\rho g) \Rightarrow \frac{1}{3}P_0 = \frac{1}{6}h\rho g$

$\Rightarrow h = \frac{2P_0}{\rho g} = \frac{2\times10^5}{10^3\times10} = 20m$.

2. (c) Apparent weight $= V(\rho-\sigma)g = \frac{m}{\rho}(\rho-\sigma)g$

where $m =$ mass of the body,

$\rho =$ density of the body

$\sigma =$ density of water

If two bodies are in equilibrium then their apparent weight must be equal.

$\therefore \frac{m_1}{\rho_1}(\rho_1-\sigma) = \frac{m_2}{\rho_2}(\rho_2-\sigma)$

$\Rightarrow \frac{36}{9}(9-1) = \frac{48}{\rho_2}(\rho_2-1)$

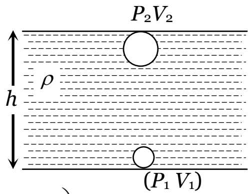
By solving we get $\rho_2 = 3$.

3. (b) According to Boyle's law, pressure and volume are inversely proportional to each other *i.e.* $P \propto \frac{1}{V}$

$\Rightarrow P_1V_1 = P_2V_2$

$\Rightarrow (P_0 + h\rho_w g)V_1 = P_0V_2$

$\Rightarrow V_2 = \left(1 + \frac{h\rho_w g}{P_0}\right)V_1$



$\Rightarrow V_2 = \left(1 + \frac{47.6\times10^2\times1\times1000}{70\times13.6\times1000}\right)V_1$

$\Rightarrow V_2 = (1+5)50\,cm^3 = 300\,cm^3$.

[As $P_2 = P_0 = 70\,cm$ of $Hg = 70\times13.6\times1000$]

4. (b) Force acting on the base

$F = P\times A = hdgA = 0.4\times900\times10\times2\times10^{-3} = 7.2N$

5. (c) 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.

6. (b) Difference of pressure between sea level and the top of hill

$\Delta P = (h_1 - h_2)\times\rho_{Hg}\times g = (75-50)\times10^{-2}\times\rho_{Hg}\times g$ ...(i)

and pressure difference due to h meter of air

$\Delta P = h\times\rho_{air}\times g$ ...(ii)

By equating (i) and (ii) we get

$h\times\rho_{air}\times g = (75-50)\times10^{-2}\times\rho_{Hg}\times g$

$\therefore h = 25\times10^{-2}\left(\frac{\rho_{Hg}}{\rho_{air}}\right) = 25\times10^{-2}\times10^4 = 2500\,m$

$\therefore$ Height of the hill = 2.5 *km*.

7. (c) Volume of ice $= \frac{M}{\rho}$, volume of water $= \frac{M}{\sigma}$.

$\therefore$ Change in volume $= \frac{M}{\rho} - \frac{M}{\sigma} = M\left(\frac{1}{\rho} - \frac{1}{\sigma}\right)$

8. (b) If two liquid of equal masses and different densities are mixed together then density of mixture

$\rho = \frac{2\rho_1\rho_2}{\rho_1+\rho_2} = \frac{2\times1\times2}{1+2} = \frac{4}{3}$

9. (d) Let M_0 = mass of body in vacuum.

Apparent weight of the body in air = Apparent weight of standard weights in air

$\Rightarrow$ Actual weight – upthrust due to displaced air

= Actual weight – upthrust due to displaced air

$\Rightarrow M_0g - \left(\frac{M_0}{d_1}\right)dg = Mg - \left(\frac{M}{d_2}\right)dg \Rightarrow M_0 = \frac{M\left[1-\frac{d}{d_2}\right]}{\left[1-\frac{d}{d_1}\right]}$

10. (c) $P = h\rho g$ *i.e.* pressure does not depend upon the area of bottom surface.

11. (c) $P_1V_1 = P_2V_2 \Rightarrow (P_0 + h\rho g)\times\frac{4}{3}\pi r^3 = P_0\times\frac{4}{3}\pi(2r)^3$

Where, h = depth of lake

$\Rightarrow h\rho g = 7P_0 \Rightarrow h = 7\times\frac{H\rho g}{\rho g} = 7H.$

12. (c) $P_1V_1 = P_2V_2 \Rightarrow (P_0 + h\rho g)V = P_0\times3V$

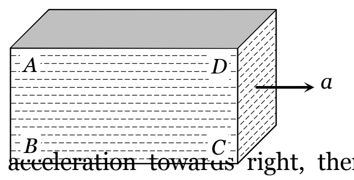
$\Rightarrow h\rho g = 2P_0 \Rightarrow h = \frac{2\times75\times13.6\times g}{\frac{13.6}{10}\times g} = 15\ m$

13. (a) $h = \frac{P}{\rho g}$ $\therefore h \propto \frac{1}{g}$ (P and ρ are constant)

If value of g decreased by 2% then h will increase by 2%.

14. (d) $h = \frac{P}{\rho g}$ $\therefore h \propto \frac{1}{g}$. If lift moves upward with some acceleration then effective g increases. So the value of h decreases *i.e.* reading will be less than 76 *cm*.

15. (a)



Due to acceleration towards right, there will be a pseudo force in a left direction. So the pressure will be more on rear side (Points A and B) in comparison with front side (Point D and C).

Also due to height of liquid column pressure will be more at the bottom (points B and C) in comparison with top (point A and D).

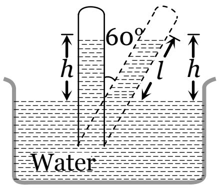
So overall maximum pressure will be at point B and minimum pressure will be at point D.

16. (b) Total pressure at (near) bottom of the liquid

$P = P_0 + h\rho g$

As air is continuously pumped out from jar (container), P_0 decreases and hence P decreases.

17. (a) $\cos 60° = \frac{h}{l}$



$\Rightarrow l = \frac{h}{\cos 60°} = \frac{76}{1/2}$

$\therefore\ l = 152\ cm$

18. (b) Pressure at the bottom = $h\rho g$

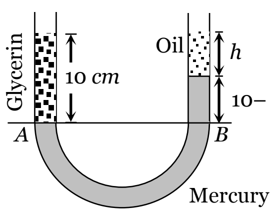
and pressure on the vertical surface = $\frac{1}{2}h\rho g$

Now, according to problem

Force at the bottom = Force on the vertical surface

$\Rightarrow h\rho g \times \pi r^2 = \frac{1}{2}h\rho g \times 2\pi r h \Rightarrow h = r$

19. (d)



At the condition of equilibrium

Pressure at point A = Pressure at point B

$P_A = P_B \Rightarrow 10 \times 1.3 \times g = h \times 0.8 \times g + (10 - h) \times 13.6 \times g$

By solving we get $h = 9.7\ cm$

20. (b) Thrust on lamina = pressure at centroid × Area

$= \frac{h\rho g}{3} \times A = \frac{1}{3}A\rho g h.$

21. (c) $\rho = \frac{\text{Total mass}}{\text{Total volume}} = \frac{2m}{V_1 + V_2} = \frac{2m}{m\left(\frac{1}{\rho_1} + \frac{1}{\rho_2}\right)}$

$\therefore \rho = \frac{2\rho_1\rho_2}{\rho_1 + \rho_2}$

22. (a) $\rho = \frac{\text{Total mass}}{\text{Total volume}} = \frac{m_1 + m_2}{2V} = \frac{V(\rho_1 + \rho_2)}{2V} = \frac{\rho_1 + \rho_2}{2}$

23. (b) Bulk modulus, $B = -V_0 \frac{\Delta p}{\Delta V} \Rightarrow \Delta V = -V_0 \frac{\Delta p}{B}$

$\Rightarrow V = V_0\left[1 - \frac{\Delta p}{B}\right]$

$\therefore$ Density, $\rho = \rho_0\left[1 - \frac{\Delta p}{B}\right]^{-1} = \rho_0\left[1 + \frac{\Delta p}{B}\right]$

where, $\Delta p = p - p_0 = h\rho_0 g$

= pressure difference between depth and surface of ocean

$\therefore\ \rho = \rho_0\left[1 + \frac{\rho_0 g y}{B}\right]$ (As $h = y$)

24. (b) Since, with increase in temperature, volume of given body increases, while mass remains constant so that density will decrease.

i.e. $\frac{\rho}{\rho_0} = \frac{m/V}{m/V_0} = \frac{V_0}{V} = \frac{V_0}{V_0(1 + r\Delta\theta)} = (1 - \gamma\Delta\theta)$

$\therefore\ \rho = \rho_0(1 - \gamma\Delta\theta)$

25. (b) $\rho_{mix} = \frac{m_1 + m_2 + m_3}{3V} = \frac{V(d + 2d + 3d)}{3V} = 2d.$

26. (b) $\rho_{mix} = \frac{3m}{V_1 + V_2 + V_3} = \frac{3m}{\frac{m}{d} + \frac{m}{2d} + \frac{m}{3d}} = \frac{3 \times 6}{11}d = \frac{18}{11}d$

27. (d) Pressure = $h\rho g$ *i.e.* pressure at the bottom is independent of the area of the bottom of the tank. It depends on the height of water upto which the tank is filled with water. As in both the tanks, the levels of water are the same, pressure at the bottom is also the same.

28. (a)

29. (c) A torque is acting on the wall of the dam trying to make it topple. The bottom is made very broad so that the dam will be stable.

30. (c)

31. (d)

Pascal's Law and Archmidies Principle

1. (c) Let the total volume of ice-berg is V and its density is ρ. If this ice-berg floats in water with volume V_{in} inside it then $V_{in}\sigma g = V\rho g \Rightarrow V_{in} = \left(\frac{\rho}{\sigma}\right)V$

or $V_{out} = V - V_{in} = \left(\frac{\sigma - \rho}{\sigma}\right)V$

$\Rightarrow \frac{V_{out}}{V} = \left(\frac{\sigma - \rho}{\sigma}\right) = \frac{1000 - 900}{1000} = \frac{1}{10}$

$\therefore\ V_{out} = 10\%$ of V

2. (a) Volume of log of wood $V = \frac{\text{mass}}{\text{density}} = \frac{120}{600} = 0.2\ m^3$

Let x weight that can be put on the log of wood.

So weight of the body = $(120 + x) \times 10\ N$

Weight of displaced liquid = $V\sigma g = 0.2 \times 10^3 \times 10\ N$

The body will just sink in liquid if the weight of the body will be equal to the weight of displaced liquid.

$\therefore\ (120+x)\times 10 = 0.2\times 10^3 \times 10$

$\Rightarrow 120 + x = 200\ \therefore\ x = 80\ kg$

3. (c) Weight of the bowl = mg

$= V\rho g = \frac{4}{3}\pi\left[\left(\frac{D}{2}\right)^3 - \left(\frac{d}{2}\right)^3\right]\rho g$

where D = Outer diameter ,

d = Inner diameter

ρ = Density of bowl

Weight of the liquid displaced by the bowl

$= V\sigma g = \frac{4}{3}\pi\left(\frac{D}{2}\right)^3 \sigma g$

where σ is the density of the liquid.

For the flotation $\frac{4}{3}\pi\left(\frac{D}{2}\right)^3 \sigma g = \frac{4}{3}\pi\left[\left(\frac{D}{2}\right)^3 - \left(\frac{d}{2}\right)^3\right]\rho g$

$\Rightarrow \left(\frac{1}{2}\right)^3 \times 1.2\times 10^3 = \left[\left(\frac{1}{2}\right)^3 - \left(\frac{d}{2}\right)^3\right] 2\times 10^4$

By solving we get d = 0.98 m.

4. (c) Specific gravity of alloy $= \frac{\text{Density of alloy}}{\text{Density of water}}$

$= \frac{\text{Mass of alloy}}{\text{Volume of alloy} \times \text{density of water}}$

$= \frac{m_1 + m_2}{\left(\frac{m_1}{\rho_1} + \frac{m_2}{\rho_2}\right)\times \rho_w} = \frac{m_1 + m_2}{\frac{m_1}{\rho_1/\rho_w} + \frac{m_2}{\rho_2/\rho_w}} = \frac{m_1+m_2}{\frac{m_1}{s_1} + \frac{m_2}{s_2}}$

$\left[\text{As specific gravity of substance} = \frac{\text{density of substance}}{\text{density of water}}\right]$

5. (b) Let specific gravities of concrete and saw dust are ρ_1 and ρ_2 respectively.

According to principle of floatation weight of whole sphere = upthrust on the sphere

$\frac{4}{3}\pi(R^3 - r^3)\rho_1 g + \frac{4}{3}\pi r^3 \rho_2 g = \frac{4}{3}\pi R^3 \times 1 \times g$

$\Rightarrow R^3\rho_1 - r^3\rho_1 + r^3\rho_2 = R^3$

$\Rightarrow R^3(\rho_1 - 1) = r^3(\rho_1 - \rho_2) \Rightarrow \frac{R^3}{r^3} = \frac{\rho_1 - \rho_2}{\rho_1 - 1}$

$\Rightarrow \frac{R^3 - r^3}{r^3} = \frac{\rho_1 - \rho_2 - \rho_1 + 1}{\rho_1 - 1}$

$\Rightarrow \frac{(R^3 - r^3)\rho_1}{r^3\rho_2} = \left(\frac{1-\rho_2}{\rho_1 - 1}\right)\frac{\rho_1}{\rho_2}$

$\Rightarrow \frac{\text{Mass of concrete}}{\text{Mass of saw dust}} = \left(\frac{1-0.3}{2.4-1}\right)\times\frac{2.4}{0.3} = 4$

6. (d) Apparent weight

$= V(\rho - \sigma)g = l\times b\times h\times(5-1)\times g$

$= 5\times 5\times 5\times 4\times g\ Dyne = 4\times 5\times 5\times 5\ gf.$

7. (a) Fraction of volume immersed in the liquid $V_{in} = \left(\frac{\rho}{\sigma}\right)V$

i.e. it depends upon the densities of the block and liquid.

So there will be no change in it if system moves upward or downward with constant velocity or some acceleration.

8. (b) Apparent weight $= V(\rho-\sigma)g = \frac{M}{\rho}(\rho - \sigma)g$

$= M\left(1 - \frac{\sigma}{\rho}\right)g = 2.1\left(1 - \frac{0.8}{10.5}\right)g = 1.94\ g\ N$

= 1.94 $Kg\text{-}wt$

9. (b, c) Density of metal = ρ , Density of liquid = σ

If V is the volume of sample then according to problem

$210 = V\rho g$ ...(i)

$180 = V(\rho - 1)g$ ...(ii)

$120 = V(\rho - \sigma)g$ ...(iii)

By solving (i), (ii) and (iii) we get $\rho = 7$ and $\sigma = 3$.

10. (c) If two different bodies A and B are floating in the same liquid then $\frac{\rho_A}{\rho_B} = \frac{(f_{in})_A}{(f_{in})_B} = \frac{1/2}{2/3} = \frac{3}{4}$

11. (c) For the floatation $V_0 d_0 g = V_{in}\ d\ g \Rightarrow V_{in} = V_0\frac{d_0}{d}$

$\therefore\ V_{out} = V_0 - V_{in} = V_0 - V_0\frac{d_0}{d} = V_0\left[\frac{d - d_0}{d}\right]$

$\Rightarrow \frac{V_{out}}{V_0} = \frac{d - d_0}{d}.$

12. (d)

13. (a) Apparent weight = $V(\rho - \sigma)g$

$= 5\times 5\times 5(7-1)g = 6\times 5\times 5\times 5\ gf$

14. (b)

15. (b) Effective weight $W' = m(g-a)$ which is less than actual weight mg, so the length of spring decreases.

16. (d) Tension in spring T = upthrust – weight of sphere

$= V\sigma g - V\rho g = V\eta\rho g - V\rho g\quad (\text{As } \sigma = \eta\rho)$

$= (\eta - 1)V\rho g = (\eta - 1)mg.$

17. (a) When body (sphere) is half immersed, then upthrust = weight of sphere

$\Rightarrow \frac{V}{2}\times\rho_{liq}\times g = V\times\rho\times g\ \therefore\ \rho = \frac{\rho_{liq}}{2}$

When body (sphere) is fully immersed then,

Upthrust = wt. of sphere + wt. of water poured in sphere

$\Rightarrow V\times\rho_{liq}\times g = V\times\rho\times g + V'\times\rho_{liq}\times g$

$\Rightarrow V\times\rho_{liq} = \frac{V\times\rho_{liq}}{2} + V'\times\rho_{liq} \Rightarrow V' = \frac{V}{2}$

18. (a) Since no change in volume of displaced water takes place, hence level of water remains same.

19. (b) The velocity of ball before entering the water surface

$v = \sqrt{2gh} = \sqrt{2g \times 9}$

When ball enters into water, due to upthrust of water the velocity of ball decreases (or retarded)

The retardation, $a = \dfrac{\text{apparent weight}}{\text{mass of ball}}$

$= \dfrac{V(\rho - \sigma)g}{V\rho} = \left(\dfrac{\rho - \sigma}{\rho}\right)g = \left(\dfrac{0.4 - 1}{0.4}\right) \times g = -\dfrac{3}{2}g$

If h be the depth upto which ball sink, then,

$0 - v^2 = 2 \times \left(-\dfrac{3}{2}g\right) \times h \Rightarrow 2g \times 9 = 3gh \therefore h = 6\ cm.$

20. (b) Upthrust = weight of body

For A, $\dfrac{V_A}{2} \times \rho_W \times g = V_A \times \rho_A \times g \Rightarrow \rho_A = \dfrac{\rho_W}{2}$

For B, $\dfrac{3}{4} V_B \times \rho_W \times g = V_B \times \rho_B \times g \Rightarrow \rho_B = \dfrac{3}{4}\rho_W$

(Since 1/4 of volume of B is above the water surface)

$\therefore \dfrac{\rho_A}{\rho_B} = \dfrac{\rho_W/2}{3/4\ \rho_W} = \dfrac{2}{3}$

21. (c)

22. (c) Since, up thrust (F) = $V\sigma g$ *i.e.* $F \propto V$

23. (b) $V\rho g = \dfrac{V}{2}\sigma g \therefore \rho = \dfrac{\sigma}{2}$ (σ = density of water)

24. (b)

25. (b)

26. (d)

27. (a)

Fluid Flow

1. (b) For streamline flow, Reynold's number $N_R \propto \dfrac{r\rho}{\eta}$ should be less. For less value of N_R, radius and density should be small and viscosity should be high.

2. (a) $d_A = 2 cm$ and $d_B = 4\ cm \therefore r_A = 1\ cm$ and $r_B = 2\ cm$

From equation of continuity, av = constant

$\therefore \dfrac{v_A}{v_B} = \dfrac{a_B}{a_A} = \dfrac{\pi(r_B)^2}{\pi(r_A)^2} = \left(\dfrac{2}{1}\right)^2 \Rightarrow v_A = 4v_B$

3. (c) If the liquid is incompressible then mass of liquid entering through left end, should be equal to mass of liquid coming out from the right end.

$\therefore M = m_1 + m_2 \Rightarrow Av_1 = Av_2 + 1.5A.v$

$\Rightarrow A \times 3 = A \times 1.5 + 1.5A.v \Rightarrow v = 1\ m/s$

4. (d) This happens in accordance with equation of continuity and this equation was derived on the principle of conservation of mass and it is true in every case, either tube remain horizontal or vertical.

5. (d) $a_1 v_1 = a_2 v_2$

$\Rightarrow 4.20 \times 5.18 = 7.60 \times v_2 \Rightarrow v_2 = 2.86\ m/s$

6. (a) Velocity head $h = \dfrac{v^2}{2g} = \dfrac{(5)^2}{2 \times 10} = 1.25\, m$

7. (d) As cross-section areas of both the tubes A and C are same and tube is horizontal. Hence according to equation of continuity $v_A = v_C$ and therefore according to Bernoulli's theorem $P_A = P_C$ *i.e.* height of liquid is same in both the tubes A and C.

8. (b) Bernoulli's theorem for unit mass of liquid

$\dfrac{P}{\rho} + \dfrac{1}{2}v^2 =$ constant

As the liquid starts flowing, it pressure energy decreases

$\dfrac{1}{2}v^2 = \dfrac{P_1 - P_2}{\rho} \Rightarrow \dfrac{1}{2}v^2 = \dfrac{3.5 \times 10^5 - 3 \times 10^5}{10^3} \Rightarrow v^2$

$= \dfrac{2 \times 0.5 \times 10^5}{10^3} \Rightarrow v^2 = 100 \Rightarrow v = 10\ m/s$

9. (a) From the Bernoulli's theorem

$P_1 - P_2 = \dfrac{1}{2}\rho(v_2^2 - v_1^2) = \dfrac{1}{2} \times 1.3 \times [(120)^2 - (90)^2]$

$= 4095\ N/m^2$ or *Pascal*

10. (c) Time taken for the level to fall from H to H'

$t = \dfrac{A}{A_0}\sqrt{\dfrac{2}{g}}\left[\sqrt{H} - \sqrt{H'}\right]$

According to problem- the time taken for the level to fall from h to $\dfrac{h}{2}$ $\quad t_1 = \dfrac{A}{A_0}\sqrt{\dfrac{2}{g}}\left[\sqrt{h} - \sqrt{\dfrac{h}{2}}\right]$

and similarly time taken for the level to fall from $\dfrac{h}{2}$ to zero $\quad t_2 = \dfrac{A}{A_0}\sqrt{\dfrac{2}{g}}\left[\sqrt{\dfrac{h}{2}} - 0\right]$

$\therefore \dfrac{t_1}{t_2} = \dfrac{1 - \dfrac{1}{\sqrt{2}}}{\dfrac{1}{\sqrt{2}} - 0} = \sqrt{2} - 1.$

11. (b) $v = \sqrt{2gh} = \sqrt{2 \times 10 \times 20} = 20\, m/s$

12. (a) Pressure at the bottom of tank $P = h\rho g = 3 \times 10^5 \dfrac{N}{m^2}$

Pressure due to liquid column

$P_l = 3 \times 10^5 - 1 \times 10^5 = 2 \times 10^5$

and velocity of water $v = \sqrt{2gh}$

$\therefore v = \sqrt{\dfrac{2P_l}{\rho}} = \sqrt{\dfrac{2 \times 2 \times 10^5}{10^3}} = \sqrt{400}\ m/s$

13. (c) Time required to emptied the tank $t = \dfrac{A}{A_0}\sqrt{\dfrac{2H}{g}}$

$\therefore \dfrac{t_2}{t_1} = \sqrt{\dfrac{H_2}{H_1}} = \sqrt{\dfrac{4h}{h}} = 2 \quad \therefore t_2 = 2t$

14. (a) The height of water in the tank becomes maximum when the volume of water flowing into the tank per second becomes equal to the volume flowing out per second.

Volume of water flowing out per second

$= Av = A\sqrt{2gh}$ ...(i)

Volume of water flowing in per second

$= 70\, cm^3/sec$ ...(ii)

From (i) and (ii) we get

$A\sqrt{2gh} = 70 \Rightarrow 1 \times \sqrt{2gh} = 70$

$\Rightarrow 1 \times \sqrt{2 \times 980 \times h} = 70$

$\therefore\ h = \dfrac{4900}{1960} = 2.5\, cm.$

15. (d) $A = (0.1)^2 = 0.01 m^2$,

$\eta = 0.01\ Poise = 0.001\ decapoise$ (M.K.S. unit),

$dv = 0.1\, m/s$ and $F = 0.002\, N$

$F = \eta A \dfrac{dv}{dx}$

$\therefore\ dx = \dfrac{\eta A dv}{F} = \dfrac{0.001 \times 0.01 \times 0.1}{0.002} = 0.0005 m$.

16. (b) $F = 6\pi\eta r v$

17. (b) In the first 100 m body starts from rest and its velocity goes on increasing and after 100 m it acquire maximum velocity (terminal velocity). Further, air friction *i.e.* viscous force which is proportional to velocity is low in the beginning and maximum at $v = v_T$.

Hence work done against air friction in the first 100 m is less than the work done in next 100 m.

18. (c) If two drops of same radius r coalesce then radius of new drop is given by R

$\dfrac{4}{3}\pi R^3 = \dfrac{4}{3}\pi r^3 + \dfrac{4}{3}\pi r^3 \Rightarrow R^3 = 2r^3 \Rightarrow R = 2^{1/3} r$

If drop of radius r is falling in viscous medium then it acquire a critical velocity v and $v \propto r^2$

$\dfrac{v_2}{v_1} = \left(\dfrac{R}{r}\right)^2 = \left(\dfrac{2^{1/3} r}{r}\right)^2$

$\Rightarrow v_2 = 2^{2/3} \times v_1 = 2^{2/3} \times (5) = 5 \times (4)^{1/3} m/s$

19. (c) Velocity of ball when it strikes the water surface $v = \sqrt{2gh}$ ...(i)

Terminal velocity of ball inside the water $v = \dfrac{2}{9} r^2 g \dfrac{(\rho - 1)}{\eta}$ ...(ii)

Equating (i) and (ii) we get $\sqrt{2gh} = \dfrac{2}{9}\dfrac{r^2 g}{\eta}(\rho - 1)$

$\Rightarrow h = \dfrac{2}{81} r^4 \left(\dfrac{\rho - 1}{\eta}\right)^2 g$

20. (b) Rate of flow of liquid $V = \dfrac{P}{R}$

where liquid resistance $R = \dfrac{8\eta l}{\pi r^4}$

For another tube liquid resistance

$R' = \dfrac{8\eta l}{\pi\left(\dfrac{r}{2}\right)^4} = \dfrac{8\eta l}{\pi r^4}.16 = 16R$

For the series combination

$V_{New} = \dfrac{P}{R + R'} = \dfrac{P}{R + 16R} = \dfrac{P}{17R} = \dfrac{V}{17}$.

21. (d) From $V = \dfrac{P\pi r^4}{8\eta l} \Rightarrow P = \dfrac{V 8\eta l}{\pi r^4}$

$\Rightarrow \dfrac{P_2}{P_1} = \dfrac{V_2}{V_1} \times \dfrac{l_2}{l_1} \times \left(\dfrac{r_1}{r_2}\right)^4 = 2 \times 2 \times \left(\dfrac{1}{2}\right)^4 = \dfrac{1}{4}$

$\Rightarrow P_2 = \dfrac{P_1}{4} = \dfrac{P}{4}$.

22. (b) $V = \dfrac{\pi P r^4}{8\eta l} = \dfrac{8 cm^3}{\text{sec}}$

For composite tube

$V_1 = \dfrac{P\pi r^4}{8\eta\left(l + \dfrac{l}{2}\right)} = \dfrac{2}{3}\dfrac{\pi P r^4}{8\eta l} = \dfrac{2}{3} \times 8 = \dfrac{16}{3}\dfrac{cm^3}{\text{sec}}$

$\left[\because\ l_1 = l = 2l_2 \text{ or } l_2 = \dfrac{l}{2}\right]$

23. (a)

24. (d)

25. (c)

26. (a) If velocities of water at entry and exit points are v_1 and v_2, then according to equation of continuity,

$A_1 v_1 = A_2 v_2 \Rightarrow \dfrac{v_1}{v_2} = \dfrac{A_2}{A_1} = \left(\dfrac{r_2}{r_1}\right)^2 = \left(\dfrac{2}{3}\right)^2 = \dfrac{4}{9}$

27. (a)

28. (b)

29. (a)

30. (a)

31. (a)

32. (b) According to Bernoulli's theorem.

33. (c)

34. (a) $\dfrac{v^2}{2g} = h \Rightarrow v = \sqrt{2gh}$

$= \sqrt{2 \times 10^3 \times 40} = 2\sqrt{2} \times 10^2 = 282.8\ cm/s$

35. (b)

36. (a,d)

37. (a,c,d) According to equation of continuity the volume of liquid flowing through the tube in unit time remains constant *i.e.* $A_1 v_1 = A_2 v_2$, hence option (a) is correct

According to Bernoulli's theorem,

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

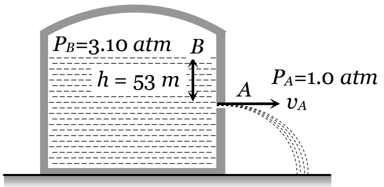
$$\Rightarrow P_1 - P_2 = \frac{1}{2}\rho\left(v_2^2 - v_1^2\right) \Rightarrow h\rho g = \frac{1}{2}\rho\left(v_2^2 - v_1^2\right)$$

$$\therefore v_2^2 - v_1^2 = 2gh$$

Hence option (c) is correct.

Also, according to Bernoulli's theorem option (d) is correct

38. (b)



According to Bernoulli's theorem,

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

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

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

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

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

39. (b) According to Bernoulli's theorem, $h = \frac{v^2}{2g}$

$$\Rightarrow h = \frac{(2.45)^2}{2 \times 10} = 0.314 = 31.4\ cm$$

$\therefore$ Height of jet coming from orifice

$= 31.4 - 10.6 = 20.8\ cm$

40. (a)

41. (a)

42. (c) 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 $x = v \times t$

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

43. (b) Horizontal range will be maximum when $h = \frac{H}{2} = \frac{90}{2}$

$= 45\ cm$ *i.e.* hole 3.

44. (b) Time taken to be emptied for h height, $t = \sqrt{\frac{2h}{g}}$

and for $\frac{h}{2}$ height, $t' = \sqrt{\frac{2h/2}{g}} = \sqrt{\frac{h}{g}}$

$$\therefore \frac{t'}{t} = \frac{1}{\sqrt{2}} \Rightarrow t' = \frac{t}{\sqrt{2}} = \frac{10}{\sqrt{2}} = 7\ minute$$

45. (d) Upthrust – weight of body = apparent weight

$$VDg - Vdg = Vda,$$

Where a = retardation of body $\therefore\ a = \left(\frac{D-d}{d}\right)g$

The velocity gained after fall from h height in air, $v = \sqrt{2gh}$

Hence, time to come in rest,

$$t = \frac{v}{a} = \frac{\sqrt{2gh} \times d}{(D-d)g} = \sqrt{\frac{2h}{g}} \times \frac{d}{(D-d)}$$

46. (c) $t = \frac{A}{a}\sqrt{\frac{2}{g}}\left[\sqrt{H_1} - \sqrt{H_2}\right]$

Now, $T_1 = \frac{A}{a}\sqrt{\frac{2}{g}}\left[\sqrt{H} - \sqrt{\frac{H}{\eta}}\right]$

and $T_2 = \frac{A}{a}\sqrt{\frac{2}{g}}\left[\sqrt{\frac{H}{\eta}} - \sqrt{0}\right]$

According to problem $T_1 = T_2$

$$\therefore \sqrt{H} - \sqrt{\frac{H}{\eta}} = \sqrt{\frac{H}{\eta}} - 0 \Rightarrow \sqrt{H} = 2\sqrt{\frac{H}{\eta}} \Rightarrow \eta = 4$$

47. (b)

48. (b)

49. (a)

50. (a)

51. (a)

52. (d)

53. (b)

54. (d)

55. (d) $V = V_1 + V_2$

$$\Rightarrow \frac{\pi P r^4}{8\eta l} = \frac{\pi P r_1^4}{8\eta l} + \frac{\pi P r_2^4}{8\eta l} \Rightarrow r^4 = r_1^4 + r_2^4$$

$$\therefore r = (r_1^4 + r_2^4)^{1/4}$$

56. (d) Given, $l_1 = l_2 = 1$, and $\frac{r_1}{r_2} = \frac{1}{2}$

$$V = \frac{\pi P_1 r_1^4}{8\eta l} = \frac{\pi P_2 r_2^4}{8\eta l} \Rightarrow \frac{P_1}{P_2} = \left(\frac{r_2}{r_1}\right)^4 = 16$$

$$\Rightarrow P_1 = 16P_2$$

Since both tubes are connected in series, hence pressure difference across combination,

$$P = P_1 + P_2 \Rightarrow 1 = P_1 + \frac{P_1}{16} \Rightarrow P_1 = \frac{16}{17} = 0.94m$$

57. (d) $V = \frac{\pi p r^4}{8\eta l}\ \therefore V \propto P r^4$ (η and l are constants)

$$\therefore \frac{V_2}{V_1} = \left(\frac{P_2}{P_1}\right)\left(\frac{r_2}{r_1}\right)^4 = 2 \times \left(\frac{1}{2}\right)^4 = \frac{1}{8}\ \therefore\ V_2 = \frac{Q}{8}$$

58. (c)

59. (c) $a_1 v_1 = a_2 v_2 \Rightarrow \frac{v_2}{v_1} = \frac{a_1}{a_2} = \left(\frac{r_1}{r_2}\right)^2$

$\Rightarrow v_2 = 3 \times (2)^2 = 12\ m/s$

60. (a) Fluid resistance is given by $R = \frac{8\eta l}{\pi r^4}$.

When two capillary tubes of same size are joined in parallel, then equivalent fluid resistance is

$$R_e = R_1 + R_2 = \frac{8\eta L}{\pi r^4} + \frac{8\eta \times 2L}{\pi (2R)^4} = \left(\frac{8\eta L}{\pi r^4}\right) \times \frac{9}{8}$$

Equivalent resistance becomes $\frac{9}{8}$ times so rate of flow will be $\frac{8}{9}X$

61. (c) A stream lined body has less resistance due to air.

62. (a)

63. (d) $\frac{P_1 - P_2}{\rho g} = \frac{v^2}{2g} \Rightarrow \frac{4.5 \times 10^5 - 4 \times 10^5}{10^3 \times g} = \frac{v^2}{2g} \therefore v = 10 m/s$

64. (c)

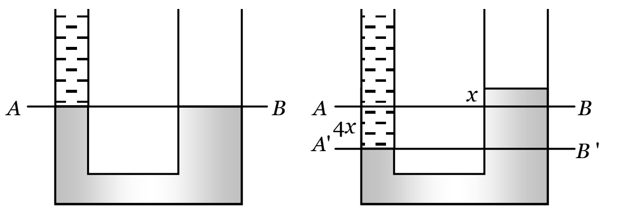
65. (c)

66. (d)

Critical Thinking Questions

1. (c) If the rise of level in the right limb be x *cm*. the fall of level of mercury in left limb be $4x$ *cm* because the area of cross section of right limb is 4 times as that of left limb.

$\therefore$ Level of water in left limb is $(36 + 4x)$ *cm*.



Now equating pressure at interface of Hg and water (at $A'B'$)

$$(36 + 4x) \times 1 \times g = 5x \times 13.6 \times g$$

By solving we get $x = 0.56$ *cm*.

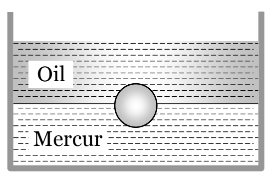
2. (a) Weight of cylinder = upthrust due to both liquids

$$V \times D \times g = \left(\frac{A}{5} \times \frac{3}{4}L\right) \times d \times g + \left(\frac{A}{5} \times \frac{L}{4}\right) \times 2d \times g$$

$$\Rightarrow \left(\frac{A}{5} \times L\right) \times D \times g = \frac{A \times L \times d \times g}{4} \Rightarrow \frac{D}{5} = \frac{d}{4} \quad \therefore D = \frac{5}{4}d$$

3. (d) As the block moves up with the fall of coin, l decreases, similarly h will also decrease because when the coin is in water, it displaces water equal to its own volume only.

4. (c)



As the sphere floats in the liquid. Therefore its weight will be equal to the upthrust force on it

Weight of sphere

$$= \frac{4}{3}\pi R^3 \rho g \quad \text{...(i)}$$

Upthrust due to oil and mercury

$$= \frac{2}{3}\pi R^3 \times \sigma_{oil} g + \frac{2}{3}\pi R^3 \sigma_{Hg} g \quad \text{...(ii)}$$

Equating (i) and (ii)

$$\frac{4}{3}\pi R^3 \rho g = \frac{2}{3}\pi R^3 0.8 g + \frac{2}{3}\pi R^3 \times 13.6 g$$

$$\Rightarrow 2\rho = 0.8 + 13.6 = 14.4 \Rightarrow \rho = 7.2$$

5. (a) Upthrust $= V\rho_{\text{liquid}}(g - a)$

where, a = downward acceleration,

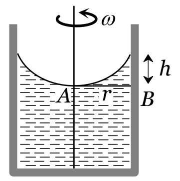
V = volume of liquid displaced

But for free fall $a = g$ $\therefore$ Upthrust = 0

6. (b) From Bernoulli's theorem,

$$P_A + \frac{1}{2}dv_A^2 + dgh_A = P_B + \frac{1}{2}dv_B^2 + dgh_B$$

Here, $h_A = h_B$



$$\therefore P_A + \frac{1}{2}dv_A^2 = P_B + \frac{1}{2}dv_B^2$$

$$\Rightarrow P_A - P_B = \frac{1}{2}d[v_B^2 - v_A^2]$$

Now, $v_A = 0, v_B = r\omega$ and $P_A - P_B = hdg$

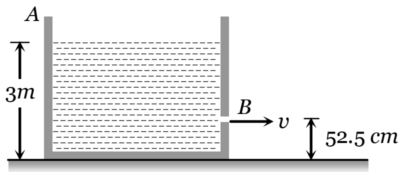
$$\therefore hdg = \frac{1}{2}dr^2\omega^2 \text{ or } h = \frac{r^2\omega^2}{2g}$$

7. (a) Let A = cross-section of tank

a = cross-section hole

V = velocity with which level decreases

v = velocity of efflux



From equation of continuity $av = AV \Rightarrow V = \frac{av}{A}$

By using Bernoulli's theorem for energy per unit volume

Energy per unit volume at point A

= Energy per unit volume at point B

$$P + \rho g h + \frac{1}{2}\rho V^2 = P + 0 + \frac{1}{2}\rho v^2$$

$$\Rightarrow v^2 = \frac{2gh}{1 - \left(\frac{a}{A}\right)^2} = \frac{2 \times 10 \times (3 - 0.525)}{1 - (0.1)^2} = 50 (m/\text{sec})^2$$

8. (b) Velocity of efflux when the hole is at depth h, $v = \sqrt{2gh}$

Rate of flow of water from square hole

$Q_1 = a_1 v_1 = L^2\sqrt{2gy}$

Rate of flow of water from circular hole

$Q_2 = a_2 v_2 = \pi R^2\sqrt{2g(4y)}$

According to problem $Q_1 = Q_2$

$\Rightarrow L^2\sqrt{2gy} = \pi R^2\sqrt{2g(4y)} \Rightarrow R = \frac{L}{\sqrt{2\pi}}$

9. (c) Let A = The area of cross section of the hole

v = Initial velocity of efflux

d = Density of water,

Initial volume of water flowing out per second = Av

Initial mass of water flowing out per second = Avd

Rate of change of momentum = Adv^2

Initial downward force on the flowing out water = Adv^2

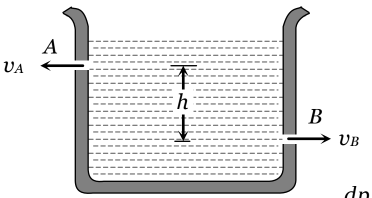
So equal amount of reaction acts upwards on the cylinder.

$\therefore$ Initial upward reaction = Adv^2 [As $v = \sqrt{2gh}$]

$\therefore$ Initial decrease in weight $= Ad(2gh)$

$= 2Adgh = 2\times\left(\frac{1}{4}\right)\times 1\times 980\times 25 = 12.5$ *gm-wt.*

10. (c)



Net force (reaction) = $F = F_B - F_A = \frac{dp_B}{dt} - \frac{dp_A}{dt}$

$= av_B\rho\times v_B - av_A\rho\times v_A$

$\therefore \quad F = a\rho\left(v_B^2 - v_A^2\right)$ ...(i)

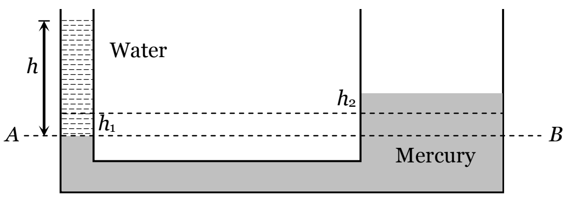
According to Bernoulli's theorem

$p_A + \frac{1}{2}\rho v_A^2 + \rho gh = p_B + \frac{1}{2}\rho v_B^2 + 0$

$\Rightarrow \frac{1}{2}\rho\left(v_B^2 - v_A^2\right) = \rho gh \Rightarrow v_B^2 - v_A^2 = 2gh$

From equation (i), $F = 2a\rho gh$.

11. (b)



If the level in narrow tube goes down by h_1 then in wider tube goes up to h_2,

Now, $\pi r^2 h_1 = \pi(nr)^2 h_2 \Rightarrow h_1 = n^2 h_2$

Now, pressure at point A = pressure at point B

$h\rho g = (h_1 + h_2)\rho' g$

$\Rightarrow h = (n^2 h_2 + h_2)sg \left(\text{As } s = \frac{\rho'}{\rho}\right) \Rightarrow h_2 = \frac{h}{(n^2+1)s}$

12. (a) Let $L = PQ$ = length of rod

$\therefore SP = SQ = \frac{L}{2}$

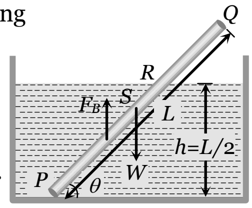
Weight of rod, $W = Al\rho g$, acting

At point S

And force of buoyancy,

$F_B = Al\rho_0 g$, $[l = PR]$

which acts at mid-point of PR.



For rotational equilibrium,

$Al\rho_0 g\times\frac{l}{2}\cos\theta = AL\rho g\times\frac{L}{2}\cos\theta$

$\Rightarrow \frac{l^2}{L^2} = \frac{\rho}{\rho_0} \Rightarrow \frac{l}{L} = \sqrt{\frac{\rho}{\rho_0}}$

From figure, $\sin\theta = \frac{h}{l} = \frac{L}{2l} = \frac{1}{2}\sqrt{\frac{\rho_0}{\rho}}$

13. (b) The volume of liquid displaced by floating ice $V_D = \frac{M}{\sigma_L}$

Volume of water formed by melting ice, $V_F = \frac{M}{\sigma_W}$

If $\sigma_1 > \sigma_W$, then, $\frac{M}{\sigma_L} < \frac{M}{\sigma_W}$ *i.e.* $V_D < V_F$

i.e. volume of liquid displaced by floating ice will be lesser than water formed and so the level if liquid will rise.

14. (a)

Graphical Questions

1. (a)

2. (b)

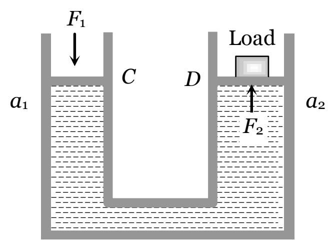
3. (d) When we move from centre to circumference, the velocity of liquid goes on decreasing and finally becomes zero.

4. (a) When cross-section of duct is decreased, the velocity of water increased and in accordance with Bernoulli's theorem, the pressure P decreased at that place.

5. (d)

Assertion and Reason

1 (b) According to Pascal's law, if gravity effect is neglected, the pressure at every point of liquid in equilibrium of rest is same.



$P_1 = P_2$ *i.e.* $\frac{F_1}{a_1} = \frac{F_2}{a_2}$ or $F_2 = \frac{a_2}{a_1} F_1$

As $a_2 >> a_1 \therefore F_2 >> F_1$

This shows that small force (F_1) applied on the smaller piston (of area a_1) will be appearing as a very large force on the larger piston.

2 (a) Height of the blood column in the human body is more at feet than at the brain. As $P = h\rho g$, therefore the blood exerts more pressure at the feet than at the brain.

3 (e) Since due to applied force on liquid, the pressure is transmitted equally in all directions inside the liquid. That is why there is no fixed direction for the pressure due to liquid. Hence hydrostatic pressure is a scalar quantity.

4 (c) Net force = actual weight – upthrust force

= Actual weight – Weight of liquid displaced.

The body will rise above the surface of liquid to such an extent that the weight of the liquid displaced by the immersed part of the body (*i.e.* upward thrust) becomes equal to the weight of the body. Thus the body will float when upward thrust is more than its actual weight. In this special case the density of solid body is less than the density of liquid.

5 (e) The level of water does not change. The reason is that on drinking the water (say *m gm*), the weight of man increases by *m gm* and hence water displaced by man increases by *m gm*, tending to raise the level. However, this much amount of water has already been consumed by the man. Therefore the level of pond remain same.

6 (a)

7 (a) In a stream line flow of a liquid, according to equation of continuity $av =$ constant.

Where a is the area of cross section and v is the velocity of liquid flow. When water flowing in a broader pipe enters a narrow pipe, the area of cross-section of water decreases therefore the velocity of water increases.

8 (b) As a man jumps-out from a height in air with a parachute, its velocity increases first, because the gravity pull dominates the viscous drag and buoyancy of air which opposes the motion. As the velocity increases, the viscous drag of air also increases and soon a stage is reached where viscous drag and buoyancy of air balances the gravity pull. Then the man with a parachute falls with a constant velocity, called terminal velocity.

9 (a) According to Bernoulli's theorem, $P + \frac{1}{2}\rho v^2 =$ a constant

i.e. when velocity is large, the pressure is less in a stream line flow of an ideal liquid through a horizontal tube.

10 (c) When a body moves through a fluid, its motion is opposed by the force of fluid friction, which increases with the speed of the body. When cars and planes move through air, their motion is opposed by the air friction, which in turn, depend upon the shape of the body. It is due to this reason that the cars or planes are given such shape (known as stream lined shaped) so that air friction is minimum. Rather the movement of air layers on the upper and lower side of stream line shape provides a lift which helps in increasing the speed of the car.

11 (c) According to Bernoulli's equation,

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

Thus, total energy of the injectable medicine depends upon second power of the velocity and first power of the pressure. It implies that total energy of the injectable medicine has greater dependence on its velocity. Therefore, a doctor adjust the flow of the medicine with the help of the size of the needle of the syringe $a_1 v_1 = a_2 v_2$) rather than the thumb pressure.

12 (a) Due to small area of cross-section of the hole, fluid flows out of the vessel with a large speed and thus the fluid possesses a large linear momentum. As no external forces acts on the system, in order to conserve linear momentum, the vessel acquires a velocity in backward direction or in other words a backward thrust results on the vessel.

13 (a) The stability of a floating body depends on the relative position of centre of gravity of a body, through which its weight acts and centre of gravity of the displaced water called centre of buoyancy through which the upthrust act.

14 (a)

15 (e) The viscosity of liquid decreases rapidly with rise of temperature. The variation of viscosity of liquid with temperature is given by $\eta_t = \eta_0(1 + \alpha t + \beta t^2)$

Where η_t and η_0 are the coefficient of viscosities at $t°C$ and $0°C$ respectively and α and β are constant.

16 (a) According to Bernoulli's theorem, when wind velocity over the wings is larger than the wind velocity under the wings, pressure of wind over the wings becomes less than the pressure of wind under the wing's. This provides the necessary lift to the aeroplane.

17 (a)

18 (a) Viscosities of fluids are markedly dependent on temperature, increasing for gases and decreasing for liquids as the temperature is increased. Thus important consideration in the design of oils for engine lubrication is to reduce the temperature variation of viscosity as much as possible.

19 (a)

20 (a) When a body falls through a viscous medium, finally, it attains terminal velocity. At this velocity, viscous force on rain drop balances the weight of the body.

21 (a) Smaller the area, larger the pressure exerted by a force

22 (d) Railways tracks are laided on large sized wooden sleepers. Due to large sized sleepers the weight of rail act on the large area. Hence, the pressure exerted is reduced appreciably.

23 (a)

24 (c) When two holes are made in the tin, air keeps on entering through the other hole. Due to this the pressure inside the tin does not become less than atmospheric pressure which happen only one hole is made.

25 (e) Terminal velocity and critical velocity are not same. Critical velocity is the velocity below which the flow of liquid is streamline.

26 (b)

27 (a)

28 (b)

Fluid Mechanics

SET Self Evaluation Test - 11

1. A tank 5 m high is half filled with water and then is filled to the top with oil of density 0.85 *g/cm*. The pressure at the bottom of the tank, due to these liquids is

(a) 1.85 *g/cm* (b) 89.25 *g/cm*
(c) 462.5 *g/cm* (d) 500 *g/cm*

2. Two substances of densities ρ_1 and ρ_2 are mixed in equal volume and the relative density of mixture is 4. When they are mixed in equal masses, the relative density of the mixture is 3. The values of ρ_1 and ρ_2 are

(a) $\rho_1 = 6$ and $\rho_2 = 2$ (b) $\rho_1 = 3$ and $\rho_2 = 5$
(c) $\rho_1 = 12$ and $\rho_2 = 4$ (d) None of these

3. A wooden block of volume 1000 *cm* is suspended from a spring balance. It weighs 12 *N* in air. It is suspended in water such that half of the block is below the surface of water. The reading of the spring balance is

(a) 10 *N* (b) 9 *N*
(c) 8 *N* (d) 7 *N*

4. Two different liquids are flowing in two tubes of equal radius. The ratio of coefficients of viscosity of liquids is 52:49 and the ratio of their densities is 13:1, then the ratio of their critical velocities will be

(a) 4 : 49 (b) 49 : 4
(c) 2 : 7 (d) 7 : 2

5. Two capillary tubes of same radius *r* but of lengths *l* and *l* are fitted in parallel to the bottom of a vessel. The pressure head is *P*. What should be the length of a single tube that can replace the two tubes so that the rate of flow is same as before

(a) $l_1 + l_2$ (b) $\frac{1}{l_1} + \frac{1}{l_2}$
(c) $\frac{l_1 l_2}{l_1 + l_2}$ (d) $\frac{1}{l_1 + l_2}$

6. A capillary tube is attached horizontally to a constant head arrangement. If the radius of the capillary tube is increased by 10% then the rate of flow of liquid will change nearly by

(a) + 10% (b) + 46%
(c) – 10% (d) – 40%

7. Two stretched membranes of area 2 *cm* and 3 *cm* are placed in a liquid at the same depth. The ratio of pressures on them is

(a) 1 : 1 (b) 2 : 3
(c) 3 : 2 (d) 2 : 3

8. Three identical vessels are filled to the same height with three different liquids *A*, *B* and $C (\rho_A > \rho_B > \rho_C)$. The pressure at the base will be

(a) Equal in all vessels (b) Maximum in vessel *A*
(c) Maximum in vessel *B* (d) Maximum in vessel *C*

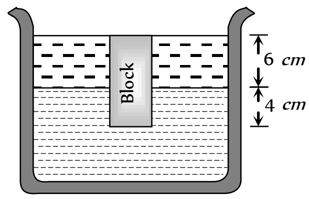
9. Three identical vessels are filled with equal masses of three different liquids *A*, *B* and C $(\rho_A > \rho_B > \rho_C)$. The pressure at the base will be

(a) Equal in all vessels (b) Maximum in vessel *A*
(c) Maximum in vessel *B* (d) Maximum in vessel *C*

10. A piston of cross-section area 100 *cm* is used in a hydraulic press to exert a force of 10 dynes on the water. The cross-sectional area of the other piston which supports an object having a mass 2000 kg. is

(a) 100 *cm* (b) 10 *cm*
(c) 2 × 10 *cm* (d) 2 × 10 *cm*

11. A cubical block of wood 10 cm on a side floats at the interface between oil and water with its lower surface horizontal and 4 cm below the interface. The density of oil is $0.6 gcm^{-3}$. The mass of block is



(a) 706 *g*
(b) 607 *g*
(c) 760 *g*
(d) 670 *g*

12. A spherical ball of radius *r* and relative density 0.5 is floating in equilibrium in water with half of it immersed in water. The work done in pushing the ball down so that whole of it is just immersed in water is : (where ρ is the density of water)

(a) $\frac{5}{12}\pi r^4 \rho g$ (b) $0.5 \rho r g$
(c) $\frac{4}{3}\pi r^3 \rho g$ (d) $\frac{2}{3}\pi r^4 \rho g$

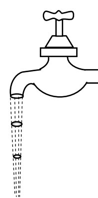
13. If W be the weight of a body of density ρ in vacuum then its apparent weight in air of density σ is

(a) $\frac{W\rho}{\sigma}$ (b) $W\left(\frac{\rho}{\sigma} - 1\right)$
(c) $\frac{W}{\rho}\sigma$ (d) $W\left(1 - \frac{\sigma}{\rho}\right)$

14. Which of the following is not the characteristic of turbulent flow

(a) Velocity more than the critical velocity
(b) Velocity less than the critical velocity
(c) Irregular flow
(d) Molecules crossing from one layer to another

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



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

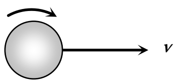
(a) As the water moves down, its speed increases and hence its pressure decreases. It is then compressed by the atmosphere

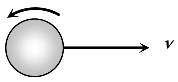
(b) Falling water tries to reach a terminal velocity and hence reduces the area of cross-section to balance upward and downward forces

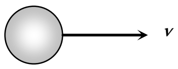
(c) The mass of water flowing past any cross-section must remain constant. Also, water is almost incompressible. Hence, the rate of volume flow must remain constant. As this is equal to velocity × area, the area decreases as velocity increases

(d) The surface tension causes the exposed surface area of the liquid to decrease continuously

16. To get the maximum flight, a ball must be thrown as

(a) 

(b) 

(c) 

(d) Any of (a), (b) and (c)

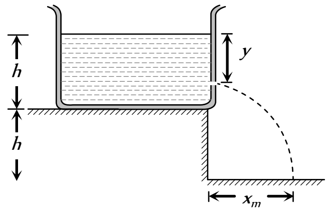
17. A tank is filled upto a height h with a liquid and is placed on a platform of height h from the ground. To get maximum range x_m a small hole is punched at a distance of y from the free surface of the liquid. Then

(a) $x_m = 2h$

(b) $x_m = 1.5h$

(c) $y = h$

(d) $y = 0.75h$



18. The relative velocity of two consecutive layers is 8 *cm/s*. If the perpendicular distance between the layers is 0.1 *cm*, then the velocity gradient will be

(a) 8 sec^{-1} (b) 80 sec^{-1}

(c) 0.8 sec^{-1} (d) 0.08 sec^{-1}

19. Under a constant pressure head, the rate of flow of liquid through a capillary tube is *V*. If the length of the capillary is doubled and the diameter of the bore is halved, the rate of flow would become

(a) $V/4$ (b) 16 V

(c) $V/8$ (d) $V/32$

Answers and Solutions

(SET - 11)

1. (c) Pressure at the bottom $P = (h_1 d_1 + h_2 d_2)\frac{g}{cm^2}$

$= [250 \times 1 + 250 \times 0.85] = 250\ [1.85]\frac{g}{cm^2}$

$= 462.5\frac{g}{cm^2}$

2. (a) When substances are mixed in equal volume then density

$= \frac{\rho_1 + \rho_2}{2} = 4 \Rightarrow \rho_1 + \rho_2 = 8$ ....(i)

When substances are mixed in equal masses then density

$= \frac{2\rho_1\rho_2}{\rho_1 + \rho_2} = 3$

$\Rightarrow 2\rho_1\rho_2 = 3(\rho_1 + \rho_2)$ ....(ii)

By solving (i) and (ii) we get $\rho_1 = 6$ and $\rho_2 = 2$.

3. (d) Reading of the spring balance

= Apparent weight of the block

= Actual weight – upthrust

$= 12 - V_{in}\sigma g$

$= 12 - 500\times10^{-6}\times10^3\times10 = 12 - 5 = 7N.$

4. (a) Critical velocity $v = N_R \dfrac{\eta}{\rho r}$

$\Rightarrow \dfrac{v_1}{v_2} = \dfrac{\eta_1}{\eta_2}\times\dfrac{\rho_2}{\rho_1} = \dfrac{52}{49}\times\dfrac{1}{13} = \dfrac{4}{49}.$

5. (c) For parallel combination $\dfrac{1}{R_{eff}} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$

$\Rightarrow \dfrac{\pi r^4}{8\eta l} = \dfrac{\pi r^4}{8\eta l_1} + \dfrac{\pi r^4}{8\eta l_2} \Rightarrow \dfrac{1}{l} = \dfrac{1}{l_1} + \dfrac{1}{l_2} \quad \therefore l = \dfrac{l_1 l_2}{l_1 + l_2}$

6. (b) $V = \dfrac{P\pi r^4}{8\eta l} \Rightarrow \dfrac{V_2}{V_1} = \left(\dfrac{r_2}{r_1}\right)^4$

$\Rightarrow V_2 = V_1\left(\dfrac{110}{100}\right)^4 = V_1(1.1)^4 = 1.4641V$

$\dfrac{\Delta V}{V} = \dfrac{V_2 - V_1}{V} = \dfrac{1.4641V - V}{V} = 0.46$ or 46%.

7. (a) Pressure is independent of area of cross section

8. (b) $P \propto \rho$

9. (a) $P = \dfrac{F}{A} = \dfrac{mg}{A}$

10. (c) $P_1 = P_2 \Rightarrow \dfrac{F_1}{A_1} = \dfrac{F_2}{A_2} \Rightarrow \dfrac{10^7}{10^2} = \dfrac{2000\times10^3\times10^3}{A_2}$

$\therefore A_2 = 2\times10^4 cm^2 \qquad (g = 980 \approx 10^3 cm/s^2)$

11. (c) Weight of block

= Weight of displaced oil + Weight of displaced water

$\Rightarrow mg = V_1\rho_0 g + V_2\rho_W g$

$\Rightarrow m = (10\times10\times6)\times0.6 + (10\times10\times4)\times1 = 760$ *gm.*

12. (a)

13. (d) Apparent weight in air = W – upthrust = $V\rho g - V\sigma g$

$= V\rho g\left(1 - \dfrac{\sigma}{\rho}\right) = W\left(1 - \dfrac{\sigma}{\rho}\right)$

14. (b)

15. (c)

16. (b)

17. (a,c) Velocity of liquid through orifice, $v = \sqrt{2gy}$

and time taken by liquid to reach the ground

$t = \sqrt{\dfrac{2(h + h - y)}{g}} = \sqrt{\dfrac{2(2h - y)}{g}}$

$\therefore$ Horizontal distance covered by liquid

$x = v.t. = \sqrt{2gy}\times\sqrt{\dfrac{2(2h-y)}{g}} = \sqrt{4y(2h-y)}$

$\Rightarrow x^2 = 4y(2h - y)$

$\Rightarrow \dfrac{d(x)^2}{dy} = 8h - 8y$

for x to be maximum, $\dfrac{d}{dy}(x^2) = 0$

$\therefore 8h - 8y = 0$ or $h = y$

So $x_m = \sqrt{4h(2h-h)} = 2h$

18. (b) $\dfrac{dv}{dx} = \dfrac{8}{0.1} = 80 s^{-1}$

19. (d) Rate of flow under a constant pressure head,

$V = \dfrac{\pi p r^4}{8\eta l} \Rightarrow V \propto \dfrac{r^4}{l} \Rightarrow \dfrac{V_2}{V_1} = \left(\dfrac{r_2}{r_1}\right)^4 \times \dfrac{l_1}{l_2} = \left(\dfrac{1}{2}\right)^4 \times \dfrac{1}{2}$

$\Rightarrow V_2 = \dfrac{V_1}{32} = \dfrac{V}{32}$