



GOVERNMENT OF KARNATAKA

DEPARTMENT OF SCHOOL EDUCATION (PRE-UNIVERSITY)

18TH CROSS, MALLESHWARAM, BENGALURU – 560 012

CHAPTER-WISE MULTIPLE-CHOICE QUESTIONS FOR COMPETITIVE EXAM

SUBJECT: I PUC - PHYSICS

NAME OF THE CHAPTER: 9. MECHANICAL PROPERTIES OF FLUIDS

SYNOPSIS

1. Pressure and Density

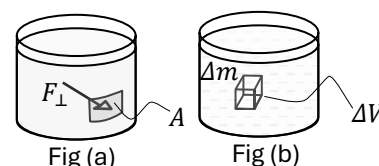
➤ If a fluid (gas or liquid) exerts a force $F_{\perp}$ perpendicular to a region having surface area A as in fig (a), then the average pressure is given by $\bar{P} = \frac{F_{\perp}}{A}$ (measured in units of *pascal* (Pa) = N.m^{-2})

➤ The pressure due to a fluid at a given point is given by $P = \frac{dF_{\perp}}{dA}$ (in *pascal* (Pa) = N.m^{-2})

➤ If Δm is the mass of a fluid element having volume ΔV as in fig (b),

then the fluid density is given by $\rho = \frac{\Delta m}{\Delta V}$

➤ The density is measured in the units of kg.m^{-3} in SI unit system.



EXAMPLE 1

The force acting on a plane surface having area A has a magnitude of F . If the direction of the force is at an angle of α to the surface, the pressure on the surface is

(A) $\frac{F \cos \alpha}{A}$

(B) $\frac{F \sin \alpha}{A}$

(C) $\frac{F \sec \alpha}{A}$

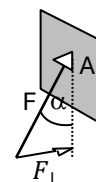
(D) $\frac{F}{A}$

Answer (B)

Example Solved:

From the diagram, the force : $F_{\perp} = F \sin \alpha$

Hence the pressure is : $\bar{P} = \frac{F_{\perp}}{A} = \frac{F \sin \alpha}{A}$



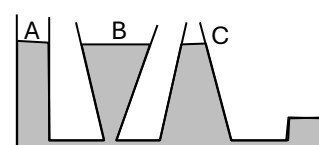
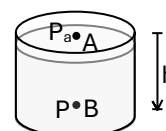
2. Variation of Pressure due to a Fluid with Depth

➤ If P_a is the atmospheric pressure (at point A) and P is the pressure due to a fluid of density ρ at a depth h (at point B) from the free surface, then

$$P = P_a + \rho gh$$

where g = acceleration due to gravity at the surface.

➤ If a liquid is filled in a container having three limbs of dissimilar shapes and sizes A, B and C, the liquid will fill to the same level in all the three limbs. This is called *hydrostatic paradox*.



EXAMPLE 2

A cylindrical beaker of depth 20 cm and open at the top contains water of density 1000 kgm^{-3} to the brim. The beaker held vertically and it is taken in an elevator moving upwards from rest, covering a distance 6 m in 2 s. If $g = 10 \text{ m/s}^2$, and atmospheric pressure is 10^5 Pa , the pressure at the bottom of the beaker is

- (A) $1.26 \times 10^5 \text{ Pa}$ (B) $3.6 \times 10^5 \text{ Pa}$ (C) $1.026 \times 10^5 \text{ Pa}$ (D) $0.126 \times 10^5 \text{ Pa}$.

Answer (C)

Example Solved:

The acceleration of the elevator is found

by applying eqns of motion

$$: y = v_0 t + \frac{1}{2} a t^2 \Rightarrow 6 = (0)(2) + \frac{1}{2} (a)(2)^2$$

Or

$$: a = 3 \text{ m/s}^2$$

Hence the pressure at the bottom of the beaker is

$$: P = P_a + \rho h(g + a)$$

Or

$$: P = 10^5 + (10^3)(0.2)(10 + 3)$$

Or

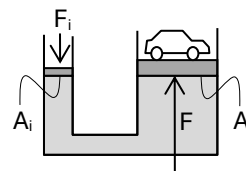
$$: P = 1.026 \times 10^5 \text{ Pa}.$$

3. Pascal's law and Hydraulic Machines

➤ According to Pascal's law, 'if an excess pressure is produced at one point of an ideal fluid, it transmits undiminished to all points in the same fluid'.

➤ One of the easiest applications of the Pascal's law is the hydraulic lift.

If A_i and A_o are the areas of the input and output pistons of the hydraulic lift, if F_i and F_o are the forces at the input and output sections respectively, then according to Pascal's law



$$P_{\text{input}} = P_{\text{output}} \quad \text{Or} \quad \frac{F_i}{A_i} = \frac{F_o}{A_o} \Rightarrow F_o = \frac{A_o}{A_i} \times F_i$$

➤ If the input and output pistons are of circular cross sections having radii of d_i and d_o respectively, then

$$F_o = \left(\frac{r_o}{r_i}\right)^2 \times F_i$$

Since $A_o \gg A_i$, we find

$$F_o \gg F_i.$$

➤ If the displacements of the input and output pistons are s_i and s_o respectively then according to the energy conservation

$$W_i = W_o \Rightarrow F_i s_i = F_o s_o \Rightarrow s_o = \frac{F_i}{F_o} \times s_i$$

and since $F_o \ll F_i$, we find

$$s_o \ll s_i.$$

➤ The other applications of the Pascal's law are (i) hydraulic brakes and (ii) hydraulic press.

EXAMPLE 3

The ratio of the output piston radius to input piston radius of a hydraulic lift is 100. If the hydraulic lift is to lift a car of mass 1000 kg slowly, the input force must be

- (A) 1 N (B) 10 N (C) 1000 N (D) 10,000 N

Answer (A)

Example Solved:

The output force is equal to the weight of the car, $: F_o = W = mg = (1000)(10) = 10,000 \text{ N}$

The ratio of the output radius to input radius $: r_o/r_i = 100.$

Hence the needed input force is found by $: F_i = \left(\frac{r_i}{r_o}\right)^2 \times F_o \Rightarrow F_i = \left(\frac{1}{100}\right)^2 \times 10,000 = 1 \text{ N}$

5. Streamline Flow and Streamlines

➤ If the velocity of a fluid particle passing through a given point of a fluid remains constant with time, the fluid flow is called **streamline flow**.

➤ The imaginary curves in a fluid such that the tangent to them at a given point gives the direction of the velocity of the fluid are called **streamlines**. They have the following properties:

(i) where streamlines are crowded, velocity of the fluid is larger and where streamlines are sparse, the velocity of the fluid is smaller.

(ii) the number of streamlines passing perpendicularly through a region having area A is proportional to vA , where v is the velocity of the fluid at that point.

(iii) no two stream lines can intersect each other.

➤ If the velocity of a fluid particle passing through a given point of a fluid DOES NOT remain constant with time, the fluid flow is called **turbulent flow**.

EXAMPLE 4

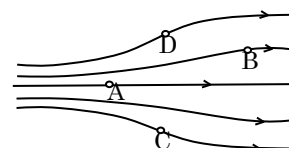
The velocity of the fluid particle in the streamlines shown is greatest at

(A) A

(B) B

(C) C

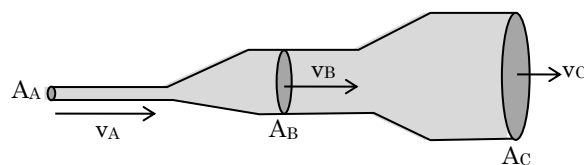
(D) D



Answer (A)

6. Continuity Equation

➤ If v_A , v_B and v_C are the velocities of the fluid across the regions of the pipe having areas of cross sections A_A , A_B and A_C respectively (as shown), then for a streamline flow, we can write



$$A_A v_A = A_B v_B = A_C v_C = \text{constant} \quad \text{Or} \quad A v = \text{constant}$$

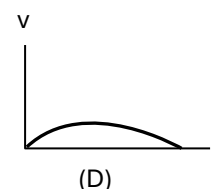
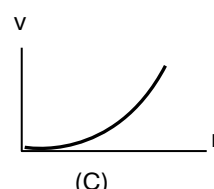
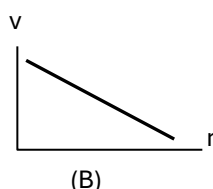
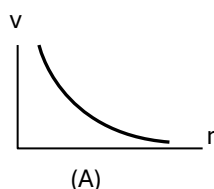
This is called **equation of continuity** or **continuity equation**.

➤ The term Av is called the volume rate flow; that is, the volume of the fluid flow per unit time;

$$R_V = \frac{dV}{dt} = Av.$$

EXAMPLE 5

The radius of a pipe supplying a fluid in streamline manner is continuously increasing. The variation of the velocity of the fluid with the radius of the pipe is correctly shown in which of the following graphs?



Answer (A)

Example Solved:

According to continuity equation,

$$: Av = \text{constant.}$$

Hence

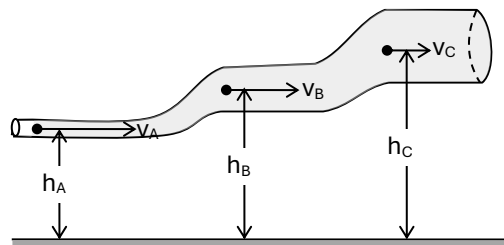
$$: v = \frac{\text{constant}}{A} \Rightarrow v = \frac{\text{constant}}{\pi r^2} \Rightarrow v \propto \frac{1}{r^2}$$

Hence as r increases

: v decreases as shown in the choice (1)

6. Bernoulli's Principle:

➤ For a streamline, non viscous and ideal flow of fluid through a pipe as shown, the sum of pressure at a point, the potential energy per unit volume and kinetic energy per unit volume at a point is a constant. This is called the Bernoulli's principle.



➤ **Bernoulli's Equation:** If v_A , v_B and v_C are velocities at the three different cross sections of the pipe, the respective kinetic energy per unit volume of the fluid are $\frac{1}{2}\rho v_A^2$, $\frac{1}{2}\rho v_B^2$ and $\frac{1}{2}\rho v_C^2$ respectively. The potential energies per unit volume at these cross sections are the ρgh_A , ρgh_B and ρgh_C respectively. If P_A , P_B and P_C are the pressures at these cross sections, then according to the Bernoulli's equation

$$P_A + \rho gh_A + \frac{1}{2}\rho v_A^2 = P_B + \rho gh_B + \frac{1}{2}\rho v_B^2 = P_C + \rho gh_C + \frac{1}{2}\rho v_C^2 = \text{constant}$$

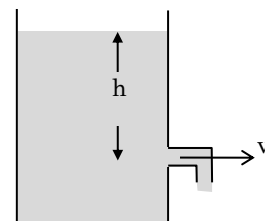
Or

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

➤ Speed of efflux:

If an open tank containing liquid of density ρ in it has a hole at a depth of h from the free end, the velocity with which the liquid comes out of the hole is called velocity of efflux:

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



EXAMPLE 6

An air plane of weight W is required to move at a constant altitude at an average speed of V relative to the air. If the area of the wings is A , the difference of velocity at the top and bottom of the air plane's wings is (take g = acceleration due to gravity and ρ as the density of air)

(A) $\frac{2W}{\rho AV}$

(B) $\frac{W}{\rho g AV}$

(C) $\frac{W AV}{\rho}$

(D) $\frac{W}{\rho AV}$

Answer (D)

Example Solved:

According to the Bernoulli's equation,

$$P_b + \frac{1}{2}\rho v_b^2 = P_t + \frac{1}{2}\rho v_t^2$$

Or

$$(P_b - P_t) = \frac{1}{2}\rho(v_t^2 - v_b^2)$$

Weight of the plane equals the lift force

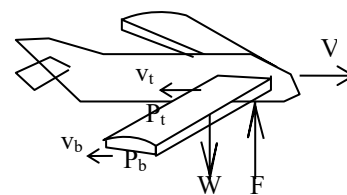
$$W = (P_b - P_t)A = \frac{1}{2}\rho A(v_t^2 - v_b^2)$$

Or

$$W = \rho A(v_t - v_b) \times \frac{v_t + v_b}{2}$$

Or

$$W = \rho A \times \Delta v \times V \Rightarrow \Delta v = \frac{W}{\rho AV}$$



EXAMPLE 7

A tank is filled with water to a depth of H whose top is open to the atmosphere. A hole is punched at a depth of h from the surface of water. The velocity of efflux is v . If v^2 and h are drawn along y and x axes respectively, the graph has a shape of

(A) straight line at some angle to the x axis (B) parabola whose axis is $+x$ axis

(C) straight line parallel to the x axis (D) parabola whose axis is $+y$ axis

Answer (A)

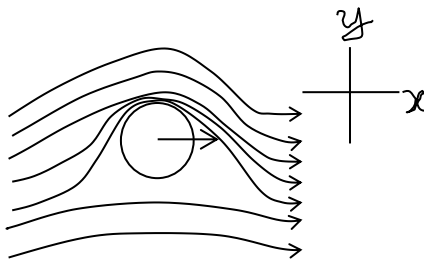
Example Solved:

Speed of efflux is given by $v = \sqrt{2gh} \Rightarrow v^2 = (2g)h \Rightarrow v^2 \propto h$

Hence the graph of v^2 vs h is a : straight line at an angle to the x axis.

EXAMPLE 8

In the figure of Magnus effect given below,
on a ball in flight inside air,
which of the following is true?



- (A) Ball spins anticlockwise and experiences a force along the +y direction.
- (B) Ball spins anticlockwise and experiences a force along the -y direction.
- (C) Ball spins anticlockwise and experiences a force along the +x direction.
- (D) Ball does not spin and doesn't experience a force.

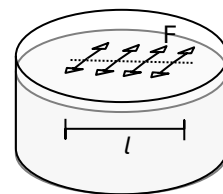
Answer (B)

7. Surface Tension

➤ If F is the force acting perpendicular to an imaginary line on a liquid surface, l is the length of that line, then the surface tension is given by

$$S = \frac{F}{l}$$

where S is measured in N/m.

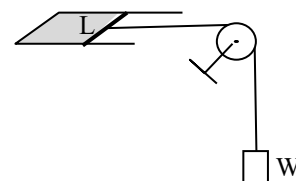


➤ If ΔU is the surface energy of the molecules of a liquid, ΔA is the area of a small section the surface of the liquid, then the surface tension is also given by

$$S = \frac{\Delta U}{\Delta A} \text{ where } S \text{ is measured in J/m}^2.$$

EXAMPLE 9

A small light rod of diameter d is placed on a U shaped wire frame. It is now immersed in a soap solution having surface tension of S . A small weight W is attached to a string which is then connected to the rod as shown in the figure. If the rod is in equilibrium, its length is



- (A) $\frac{W}{S}$
- (B) $\frac{W}{2S}$
- (C) $\frac{Wd}{2S}$
- (D) $\frac{2W}{S}$

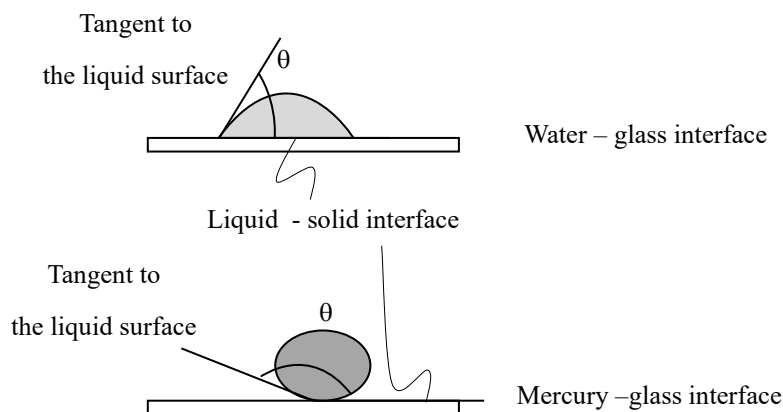
Answer (B)

Example Solved:

Force of surface tension on the rod to the left = weight of the object $: F = W$

Hence $: 2SL = W \Rightarrow L = \frac{W}{2S}$

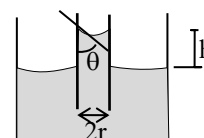
- The *surface tension* of liquids **decreases** with the **increase of temperature**.
- **Angle of contact:** The angle between the tangent drawn to the surface of the liquid in contact with a solid and the liquid - solid interface is called angle of contact.



➤ For water – glass pair, the angle of contact is acute and for mercury – glass pair, the angle of contact is obtuse.

➤ **Capillary Rise:** If r is the radius of the capillary rise of a liquid of density ρ to a height

h through a capillary tube, then
$$h = \frac{2S \cos \theta}{\rho g r}$$



where S is the surface tension of the liquid and θ is the angle of contact between the material of the tube.

EXAMPLE 10

The ratio of surface tensions of two liquids A and B is 3 : 2. Capillary tubes having areas of cross section in the ratio of 16 : 9 are immersed in the respective liquids. If the capillary rises through them are same, the densities of the liquids are in the ratio of (assume that the angle of contact as zero)

(A) $\frac{2}{1}$

(B) $\frac{1}{2}$

(C) $\frac{1}{4}$

(D) $\frac{3}{2}$

Answer (B)

Example Solved:

From the relation for capillary rise

$$: h = \frac{2S \cos \theta}{\rho g r} \Rightarrow \rho = \frac{2S \cos \theta}{h g r}$$

Since h and g are constants in

this case, and angle of contact is

zero, so that $\cos \theta = 1$

$$: \rho \propto \frac{S}{r} \Rightarrow \rho \propto \frac{S}{\sqrt{A}} \because A = \pi r^2 \Rightarrow r^2 = \frac{A}{\pi} \Rightarrow r = \sqrt{\frac{A}{\pi}} \Rightarrow r \propto \sqrt{A}$$

Hence

$$: \frac{\rho_A}{\rho_B} = \frac{S_A}{S_B} \times \sqrt{\frac{A_B}{A_A}} \Rightarrow \frac{\rho_A}{\rho_B} = \frac{2}{3} \times \sqrt{\frac{9}{16}} = \frac{1}{2}$$

➤ **Excess pressures inside the bubbles and liquid drops:**

➤ The excess pressure inside a liquid bubble having surface tension S is given by $\Delta P_{\text{bubble}} = \frac{4S}{r}$

where r is the radius of the bubble.

➤ The excess pressure inside a liquid drop having surface tension S is given by

$$\Delta P_{\text{drop}} = \frac{2S}{r}$$

where r is the radius of the bubble.

EXAMPLE 11

The excess pressure inside a liquid bubble is 0.05 atm. If its radius is 0.4 cm, the work done to produce the bubble is (take 1 atm = 10^5 Pa)

- (A) $0.32mJ$ (B) $0.64mJ$ (C) $0.32\pi mJ$ (D) $0.64\pi mJ$

Answer (D)

Example Solved:

The surface tension and the excess pressure are related thus : $\Delta P_{bubble} = \frac{4S}{r} \Rightarrow S = \frac{r \times \Delta P_{bubble}}{4}$

Work done to produce the bubble s = surface energy stored

$$: W = \Delta U = S \times 2(4\pi r^2) = S \times 2(4\pi r^2)$$

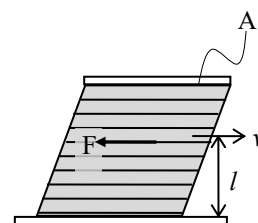
$$\text{Or} \quad : W = \frac{r \times \Delta P_{bubble}}{4} \times 2(4\pi r^2) = 2\pi r^3 \Delta P_{bubble}$$

$$\text{Or} \quad : W = 2\pi (4 \times 10^{-3})^3 \times 5 \times 10^3 = 0.64\pi (mJ)$$

8. Viscosity:

➤ A liquid is placed between a rigid support and a light metal plate. The plate is moved at constant velocity to the right. If the velocity gradient of the liquid is $\frac{v}{l}$, A is the area of cross section of the liquid, then the viscous force between any two liquid layers is

$$F = \eta A \frac{v}{l}$$

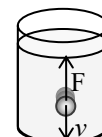


Where η is the coefficient of viscosity measured in units of **Pa.s**.

➤ Viscosity of liquids **decreases** with the **increase of temperature**, while for gases, it **increases** with the **increase of temperature**.

➤ **Stokes' Law:** When a spherical object of radius a is made to sink through a viscous fluid having coefficient of viscosity η , the viscous force on it is given by $F = 6\pi\eta av$

where v is the velocity of the fluid. This is called Stoke's law.



➤ When the spherical object moves at constant velocity called terminal velocity (v_t) in the liquid the forces acting on it are

(1) viscous force acting upwards, (2) buoyant force acting upwards and (3) weight of the object downwards.

$$\text{Hence } F_{\text{visc}} + F_{\text{buoy}} = F_g \Rightarrow$$

$$v_t = \frac{2a^2}{9\eta} (\rho_{\text{sol}} - \rho_{\text{liq}})g \quad \text{or} \quad v_t = \frac{2a^2 \Delta \rho g}{9\eta}$$

where $\Delta \rho$ = difference in density between the spherical solid and liquid.

EXAMPLE 12

A flat plate of area 20 cm^2 is placed on a horizontal surface coated with a layer of glycerine 1 mm thick. The force that must be applied to the plate to keep it moving with a speed of 1 cm/s over the horizontal surface is (Coefficient of viscosity of glycerine = 2 Pa.s)

- (A) $2.0 \times 10^{-3} \text{ N}$ (B) 2.0 N (C) $1.0 \times 10^{-4} \text{ N}$ (D) $4.0 \times 10^{-2} \text{ N}$

Answer (D)

Example Solved:

The needed force is equal to the viscous force

$$: F = \frac{\eta A v}{d} = 2 \times 20 \times 10^{-4} \times 1 \times 10^{-2} / 1 \times 10^{-3} = 4 \times 10^{-2} \text{N}$$

EXAMPLE 13

Two spherical balls have surface areas in the ratio of 1 : 2. They are released in liquids having viscosities in the ratio of 2 : 3. If the ratio of the density difference between the solid and liquid for the two pairs is 3 : 2, the terminal velocities of the two spherical balls are in the ratio of

(A) 1 : 2

(B) 3 : 4

(C) 4 : 9

(D) 9 : 8

Answer (D)

Example Solved:

From the relation, we find that

$$: v_t = \frac{2 a^2 \Delta \rho g}{9 \eta} \Rightarrow v_t \propto \frac{a^2 \Delta \rho}{\eta} \Rightarrow v_t \propto \frac{A \Delta \rho}{\eta} \therefore \text{area } A \propto a^2$$

Hence

$$: \frac{v_{t,1}}{v_{t,2}} = \frac{A_1}{A_2} \times \frac{\Delta \rho_1}{\Delta \rho_2} \times \frac{\eta_2}{\eta_1} \Rightarrow \frac{v_{t,1}}{v_{t,2}} = \frac{1}{2} \times \frac{3}{2} \times \frac{3}{2} = \frac{9}{8}$$

PRACTICE QUESTIONS - MECHANICAL PROPERTIES OF FLUIDS

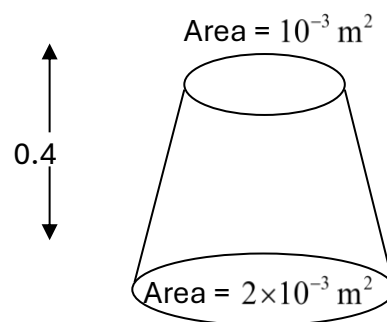
1. The force exerted by a liquid at rest is always _____ to the surface with which it is in contact
(A) Normal (B) tangential (C) oblique (D) any one of the above
2. Pressure at a point in a vessel containing a liquid
(A) varies directly as the depth below the liquid surface
(B) varies inversely as the depth of the point below the liquid surface
(C) is independent of the depth of the point
(D) varies directly as the square of the depth of the point.
3. Two thin circular discs A and B of radii 2 cm and 4 cm are in a liquid at the same depth. T_A is the thrust on A and T_B that on B. $T_A : T_B$ is
(A) 2 : 1 (B) 1 : 2 (C) 4 : 1 (D) 1 : 4
4. Ink from a fountain pen leaks when in an aeroplane because
(A) temperature increases with altitude
(B) temperature decreases with altitude
(C) atmospheric pressure decreases with altitude
(D) atmospheric pressure increases with altitude
5. The pressure in the water pipe at the basement of a building is $2 \times 10^6 \text{ Nm}^{-2}$. The height of the tank above the pipe from which water is supplied is ($g=10 \text{ m s}^{-2}$)
(A) 20 m (B) 100 m (C) 200 m (D) 400 m
6. A U tube contains water and methylated spirit separated by mercury. The mercury levels in the two arms are in level with 0.2 m of water in one arm and 0.25 m of spirit in the other. If the density of water $=10^3 \text{ kg m}^{-3}$, then the density of spirit is
(A) $1.25 \times 10^3 \text{ kg m}^{-3}$ (B) $0.8 \times 10^3 \text{ kg m}^{-3}$
(C) $0.5 \times 10^3 \text{ kg m}^{-3}$ (D) $0.125 \times 10^3 \text{ kg m}^{-3}$.
7. A body weighs 320 g in air and 260 g in water and 272 g in an oil. Specific gravity of oil is
(A) 0.8 (B) 1.25 (C) 8 (D) 12.5
8. Water flows steadily through a tube AB of varying cross-section. Area of cross-section of face A is $1.2 \times 10^{-4} \text{ m}^2$ while that of B is $2.4 \times 10^{-6} \text{ m}^2$. Velocity of liquid at A is $5 \times 10^{-2} \text{ m s}^{-1}$. That at B is
(A) 2.5 m s^{-1} (B) 25 m s^{-1} (C) 0.5 m s^{-1} (D) 5 m s^{-1}
9. Water flows through a hose pipe of internal diameter 4 cm at a speed of 1 m s^{-1} . If the water emerges from the nozzle at a speed of 4 m s^{-1} , the internal diameter of the nozzle is:
(A) 1 cm (B) 2 cm (C) 0.1 cm (D) 0.2 cm
10. When a fast jet of air is blown through the region between two spheres suspended near each other, the spheres
(A) move away (B) come closer to each other
(C) remain undisturbed (D) are blown off

11. If the pressure at half the depth of a lake is equal to $\frac{2}{3}$ pressure at the bottom of the lake then what is the depth of the lake?

- (A) 10 m (B) 20 m (C) 60 m (D) 30 m

12. A uniformly tapering vessel is filled with a liquid of density 900 kg/m^3 . The force that acts on the base of the vessel due to the liquid is ($g = 10 \text{ m s}^{-2}$)

- (A) 3.6 N (B) 7.2 N
(C) 9.0 N (D) 14.4 N



13. 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 10^4 . The height of the hill is

- (A) 250 m (B) 2.5 km (C) 1.25 km (D) 750 m

14. The pressure at the bottom of a tank containing a liquid does not depend on

- (A) Acceleration due to gravity (B) Height of the liquid column
(C) Area of the bottom surface (D) Nature of the liquid

15. 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 lakes is

- (A) H (B) $2H$ (C) $7H$ (D) $8H$

16. 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 $\frac{1}{10}$ of the density of mercury, the depth of the lake is

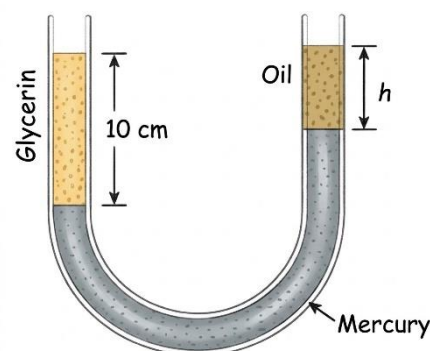
- (A) 5 m (B) 10 m (C) 15 m (D) 20 m

17. A mercury barometer reads 76 cm. If the barometer tube is now inclined at an angle of 60° to the vertical, while its open end remains immersed in the mercury reservoir, the length of the mercury column in the tube is

- (A) 152 cm (B) 76 cm (C) 38 cm (D) $38\sqrt{3} \text{ cm}$

18. A vertical U - tube of uniform inner cross section contain mercury in both sides of its arms. A glycerine (density = 1.3 g/cm^3) column of length 10 cm is introduced into one of its arms. Oil of density 0.8 g/cm^3 is poured into the other arm until the upper surfaces of the oil and glycerine are in the same horizontal level. Find the length of the oil column, density of mercury = 13.6 g/cm^3 .

- (A) 10.4 cm (B) 8.2 cm (C) 7.2 cm (D) 9.6 cm

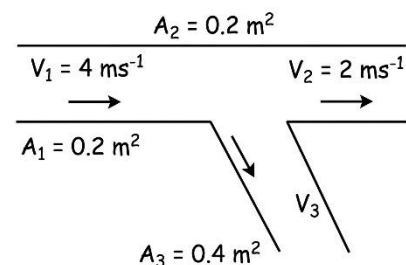


19. A block of wood weights 4 N in air and 3 N when immersed in a liquid. The buoyant force in newton is

- (A) Zero (B) 1 (C) $\frac{3}{4}$ (D) 4

20. In the steady flow of fluid as shown in the figure, the velocity V_3 will be

- (A) zero
- (B) 4 m s^{-1}
- (C) 1 m s^{-1}
- (D) 3 m s^{-1}



21. A diver descends to a depth of 30 m in a lake. If the density of water is 1000 kg m^{-3} and atmospheric pressure is $1.0 \times 10^5 \text{ Pa}$, the absolute pressure experienced by the diver is (Take $g = 10 \text{ m s}^{-2}$)

- (A) $2.0 \times 10^5 \text{ Pa}$
- (B) $3.0 \times 10^5 \text{ Pa}$
- (C) $4.0 \times 10^5 \text{ Pa}$
- (D) $5.0 \times 10^5 \text{ Pa}$

22. Water flows through a pipe of diameter 6 cm with speed 3 m/s. If the pipe narrows to 3 cm, the speed becomes

- (A) 6 m/s
- (B) 9 m/s
- (C) 12 m/s
- (D) 18 m/s

23. Water flows horizontally through a pipe. At one point velocity is 2 m/s and pressure is $2 \times 10^5 \text{ Pa}$. If at another point velocity is 6 m/s, the pressure is (Take density = 1000 kg m^{-3})

- (A) $1.84 \times 10^5 \text{ Pa}$
- (B) $2.16 \times 10^5 \text{ Pa}$
- (C) $1.68 \times 10^5 \text{ Pa}$
- (D) $2.32 \times 10^5 \text{ Pa}$

24. An iceberg floats in seawater of density 1030 kg/m^3 . Density of ice is 920 kg/m^3 . Fraction of iceberg submerged is

- (A) 0.82
- (B) 0.89
- (C) 0.92
- (D) 1.12

25. A body weighs 90 N in air and 60 N in water. Relative density of the material is

- (A) 1.5
- (B) 2
- (C) 3
- (D) 4

26. Surface tension of water is 0.072 N/m . The excess pressure inside a soap bubble of radius 2 mm is

- (A) 36 Pa
- (B) 72 Pa
- (C) 144 Pa
- (D) 288 Pa

27. Water rises to 6 cm in a capillary tube. If another tube has radius three times larger, capillary rise becomes

- (A) 18 cm
- (B) 6 cm
- (C) 3 cm
- (D) 2 cm

28. A sphere experiences a viscous force of 0.8 N while moving at 2 m/s. Assuming Stokes' law is applicable, the viscous force when it is moving with 5 m/s is

- (A) 1 N
- (B) 2 N
- (C) 4 N
- (D) 5 N

29. Pressure increases by $1.5 \times 10^5 \text{ Pa}$ when moving vertically downward by 15 m in a liquid. Density of the liquid is (Take $g = 10 \text{ m s}^{-2}$)

- (A) 800 kg/m^3
- (B) 900 kg/m^3
- (C) 1000 kg/m^3
- (D) 1200 kg/m^3

30. A force of 60 N is applied to a piston of area 2 cm^2 . The pressure is transmitted to a second piston of area 150 cm^2 according to Pascal's law. The force exerted on the larger piston is

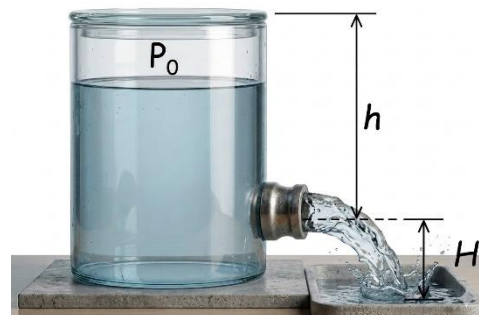
- (A) 1800 N
- (B) 3600 N
- (C) 4500 N
- (D) 6000 N

KEY ANSWERS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	A	D	C	C	B	A	A	B	B	B	B	B	C	C
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
C	A	D	B	C	C	C	A	B	C	C	D	B	C	C

PREVIOUS YEAR QUESTIONS (2020 Onwards)

1. Iceberg floats in water with part of it submerged. What is the fraction of the volume of iceberg submerged if the density of ice is $\rho_i = 0.917 \text{ g cm}^{-3}$? (2020)
 (A) 0.458 (B) 0 (C) 0.917 (D) 1
2. Two capillary tubes P and Q are dipped vertically in water. The height of water level in capillary tube P is $\frac{2^{rd}}{3}$ of the height in capillary tube Q . The ratio of their diameter is _____ (2021)
 (A) 2: 3 (B) 3: 2 (C) 3: 4 (D) 4: 3
3. A closed water tank has cross-sectional area A . It has a small hole at a depth of h from the free surface of water. The radius of the hole is r so that $r \ll \sqrt{\frac{A}{\pi}}$. If P_0 is the pressure inside the tank above water level, and P_a is the atmospheric pressure, the rate of flow of the water coming out of the hole is [ρ is the density of water] (2023)
 (A) $\pi r^2 \sqrt{2gh + \frac{2(P_0 - P_a)}{\rho}}$ (B) $\pi r^2 \sqrt{2gH}$
 (C) $\pi r^2 \sqrt{gh + \frac{2(P_0 - P_a)}{\rho}}$ (D) $\pi r^2 \sqrt{2gh}$
4. Water flows through a horizontal pipe of varying cross-section at a rate of $0.314 \text{ m}^3 \text{ s}^{-1}$. The velocity of water at a point where the radius of the pipe is 10 cm is (2024)
 (A) 0.1 m s^{-1} (B) 1 m s^{-1} (C) 10 m s^{-1} (D) 100 m s^{-1}
5. While determining the co-efficient of viscosity of the given liquid, a spherical steel ball sinks by a distance $h = 0.9 \text{ m}$. The radius of the ball is $r = \sqrt{3} \times 10^{-3} \text{ m}$. The time taken by the ball to sink in three trials are tabulated as follows. The difference between the densities of the steel ball and the liquid is 7000 kg m^{-3} . and $g = 10.0 \text{ ms}^{-2}$ (2025)



Trial No.	Time taken by the ball to fall by h (in second)
1	2.75
2	2.65
3	2.70

- (A) 0.28 Pa s (B) 0.14 Pa s (C) $0.14 \times 10^{-3} \text{ Pa s}$ (D) 14 Pa s
6. A horizontal pipe carries water in a streamlined flow. At a point along the pipe, where the cross-sectional area is 10 cm^2 , the velocity of water is 1 ms^{-1} and the pressure is 2000 Pa . What is the pressure of water at another point where the cross-sectional area is 5 cm^2 ? (2025)
 (A) 200 Pa (B) 300 Pa (C) 400 Pa (D) 500 Pa
7. Instrument fitted in the carburetor of the automobile to provide the correct mixture of air and fuel necessary for combustion works on (2026)
 (A) Pascal's law (B) Bernoulli's Principle
 (C) Newton's law of Cooling (D) Archimedes Principle
8. In a capillary tube experiment, a vertical 30 cm long capillary tube is dipped in water, water rises up to a height of 10 cm due to capillarity. If this experiment is conducted in a freely falling water in an elevator, then the length of the water column becomes (2026)
 (A) 10 cm (B) 20 cm (C) 30 cm (D) zero

KEY ANSWERS

1	2	3	4	5	6	7	8
C	B	A	C	B	D	B	C