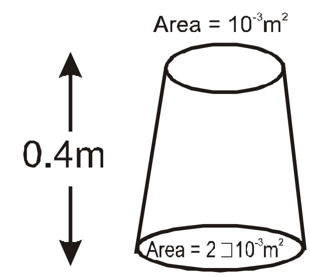
# EXERCISE – 1
## BUILDING A FOUNDATION

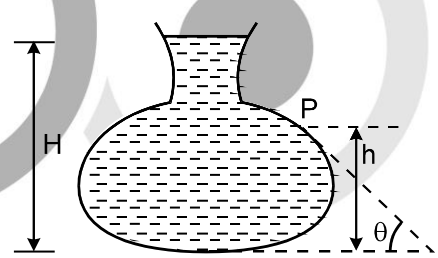
**SECTION-A MEASUREMENT AND CALCULATION OF PRESSURE**

**A-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
(a) 10m (b) 20m (c) 60m (d) 30m

**A-2.** A uniformly tapering vessel is filled with a liquid of density 900 kg/m3. The force that acts on the base of the vessel due to the liquid is (g = 10 m$s^{-2}$ )
(a) 3.6 N
(b) 7.2 N
(c) 9.0 N
(d) 14.4 N



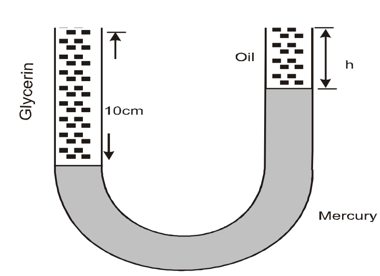

**A-3.** Figure here shown the vertical cross-section of a vessel filled with a liquid of density r. The normal thrust per unit area on the walls of the vessel at point. P, as shown, will be




(a) h r g (b) H r g (c) (H – h) r g (d) (H – h) r g cosq

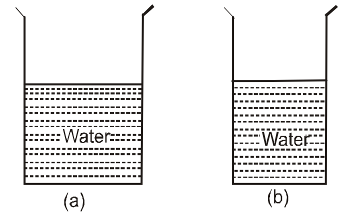
**A-4.** The pressure at the bottom of a tank containing a liquid does not depend on
(a) Acceleration due to gravity (b) Height of the liquid column
(c) Area of the bottom surface (d) Nature of the liquid

**A-5.** A vertical U-tube of uniform inner cross section contains mercury in both sides of its arms. A glycerin (density =1.3g/cm3) column of length 10cm is introduced into one of its arms. Oil of density 0.8 gm/cm3 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/cm3
(a) 10.4cm
(b) 8.2 cm
(c) 7.2cm
(d) 9.6cm



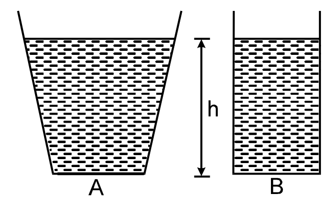

**A-6.** From the adjacent figure, the correct observation is
(a) The pressure on the bottom of tank (a) is greater than at the bottom of (b).

(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




**A-7.** A tank with length 10 m, breadth 8 m and depth 6m is filled with water to the top. If g = 10 m$s^{-2}$ and density of water is 1000 kg$m^{-3}$, then the thrust on the bottom is
(a) 6 × 1000 × 10 × 80 N
(b) 3 × 1000 × 10 × 48 N
(c) 3 × 1000 × 10 × 60 N
(d) 3 × 1000 × 10 × 80 N

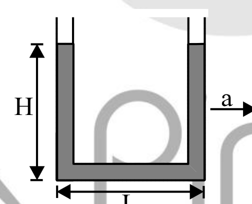
**A-8.** Two vessels A and B of different shapes have the same base area and are filled with water up to the same height h (see figure). The force exerted by water on the base is $F_A$ for vessel A and $F_B$ for vessel B. The respective weights of the water filled in vessels are $W_A$ and $W_B$. Then




(a) $F_A > F_B$ ; $W_A > W_B$
(b) $F_A = F_B$ ; $W_A > W_B$
(c) $F_A = F_B$ ; $W_A < W_B$
(d) $F_A > F_B$ ; $W_A = W_B$

**A-9.** 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

**A-10.** A liquid stands at the same level in the U-tube when at rest. If area of cross-section of both the limbs are equal, the difference in height h of the liquid in the two limbs of U-tube, when the system is given an acceleration a in horizontal direction as shown, is :

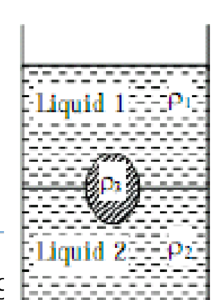



(a) $\frac{gL^2}{aH}$
(b) $\frac{La}{g}$
(c) $\frac{aL^2}{gH}$
(d) $\frac{Hg}{a}$

**A-11.** An incompressible liquid of density ρ is contained in a vessel of uniform cross-sectional area A. If the atmospheric pressure is p, then the force acting on a horizontal plane of area a situated at a depth d in liquid is given by :
(a) $Ap + apgd$
(b) $\frac{p}{A} + \frac{\rho gd}{a}$
(c) $\frac{p+\rho gd}{a}$
(d) $a(\rho gd + p)$

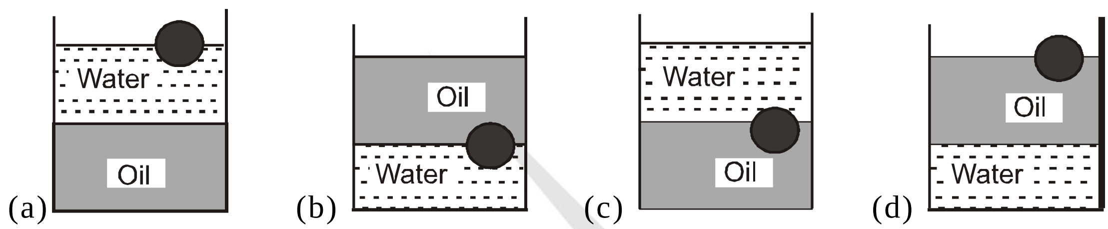
## SECTION-B ARCHEMEDIES PRINCIPLE AND FORCE OF BUOYANCY

**B-1.** A jar is filled with two non-mixing liquids 1 and 2 having densities $\rho_1$ and $\rho_2$, respectively. A solid ball, made of a material of density $\rho_3$, is dropped in the jar. It comes to equilibrium in the position shown in the figure. Which of the following is true for $\rho_1$, $\rho_2$ and $\rho_3$ ?



(a) $\rho_1>\rho_3>\rho_2$
(b) $\rho_1<\rho_2<\rho_3$
(c) $\rho_1<\rho_3<\rho_2$
(d) $\rho_3<\rho_1<\rho_2$

**B-2.** A ball is made of a material of density r where $\rho_{oil} < \rho < \rho_{water}$ with $\rho_{oil}$ and $\rho_{water}$ representing the densities of oil and water, respectively. The oil and water are immiscible. If the above ball is in equilibrium in a mixture of this oil and water, which of the following pictures represents its equilibrium position?




**B-3.** 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

**B-4.** 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
(a) It will slowly come back to its earlier position position
(b) It will remain submerged, where it is left
(c) It will sink
(d) It will come out violently

**B-5.** A rectangular block is 5cm x 5cm x 10cm 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

**B-6.** A bot carrying steel balls is floating on the surface of water in a tank. If the ball are thrown into the tank one by one how will it affect the level of water
(a) It will remain unchanged (b) It will rise
(c) It will fall (d) First it will first rise and then fall

**B-7.** 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

**B-8.** An ice block contains a glass ball when the ice melts with in the water containing, the level of water
(a) Rises (b) Falls
(c) Unchanged (d) First rises and then falls

**B-9.** Construction of submarines is based on
(a) Archimedes' principle (b) Bernoulli's theorem
(c) Pascal's law (d) Newton's laws

**B-10.** A hydrogen balloon released on the moon would:
(a) climb up with an acceleration of 9.8 m/$s^2$
(b) climb up with an acceleration of 9.8×6 m/$s^2$
(c) neither climb nor fall
(d) fall with an acceleration of $\frac{9.8}{6}$ m/$s^2$

**B-11.** 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

**B-12.** The fraction of a floating object of volume V0 and density d0 above the surface of a liquid of density d will be
(a) $\frac{d_0}{d}$ (b) $\frac{dd_0}{d+d_0}$ (c) $\frac{d-d_0}{d_0}$ (d) $\frac{dd_0}{d-d_0}$

**B-13.** The density of ice is x gm/cc and that of water is y gm/cc. What is the change in volume in cc, when m gm of ice melts ?
(a) M (y – x) (b) (y – x)/m (c) mxy (x – y) (d) m (1/y – 1/x)

**B-14.** The reading of a spring balance when a block is suspended from it in air is 60 newton. This reading is changed to 40 newton when the block is submerged in water. The specific gravity of the block must be therefore :
(a) 3 (b) 2 (b) 6 (d) 3/2

**B-15.** 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

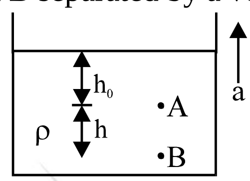
**B-16.** In order that a floating object be in a stable rotation at equilibrium, its centre of buoyancy should be
(a) vertically above its centre of gravity
(b) vertically below its centre of gravity
(c) horizontally in line with its centre of gravity
(d) may be anywhere

**B-17.** A boy carries a fish in one hand and a bucket of water in the other hand; if he places the fish in the bucket, the weight now carried by him :
(a) is less than before (b) is more than before
(c) is the same as before (d) depends upon his speed.

**B-18.** An iceberg is floating partially immersed in sea water. If the density of sea water is 1.03g/cc and that of ice is 0.92 g/cc , the fraction of the total volume of iceberg above the level of sea water is :
(A) 8% (B) 11% (C) 34% (D) 89%.

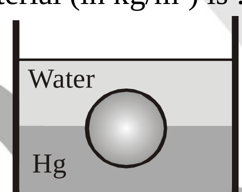
**B-19.** A barometer kept in a stationary elevator reads 76 cm. If the elevator starts accelerating up the reading will be :
(a) zero (b) equal to 76 cm
(c) more than 76 cm (d) less than 76 cm

**B-20.** A container filled with a liquid of density ρ is accelerated upwards with a. The difference in pressure between the two points A and B separated by a vertical distance h is :




(a) $\rho(g - a)h$ (b) $\rho(g + a)h$ (c) $\rho gh$ (d) $\rho ah$

**B-21.** A vessel contains oil (density = 800 kg/m$^3$) over mercury (density = 13600 kg/m$^3$). A homogeneous sphere floats with half of its volume immersed in mercury and the other half in oil as shown as figure. The density of the material (in kg/m$^3$) is :




(a) 3300 (b) 6400 (c) 7200 (d) 2800

**B-22.** When a body of density ρ and volume V is floating in a liquid of density σ , then choose the incorrect option :
(a) loss in its weight is Vσg
(b) its true weight is Vρg
(c) its true weight is zero
(d) its density ρ is less than that of liquid.



**SECTION-C PASCAL LAW & CONTINUITY EQUATION**

**C-1.** In a hydraulic lift, used at a service station the radius of the large and small piston are in the ratio of 20 : 1. What weight placed on the small piston will be sufficient to lift a car of mass 1500 kg ?
(a) 3.75 kg (b) 37.5 kg (c) 7.5 kg (d) 75 kg.

**C-2.** Two water popes 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
(a) 4 time that in the other pipe (b) $\frac{1}{4}$ time that in the other pipe
(c) 2 time that in the other pipe (d) $\frac{1}{2}$ time that in the other pipe

**C-3.** 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

**C-4.** Water is moving with a speed of 5.18 m$s^{-1}$ through a pipe with a cross-sectional area of 4.20 c$m^2$. The water gradually descends 9.66 m as the pipe increase in area to 7.60 c$m^2$. The speed of flow at the lower level is

(a) 3.0 m$s^{-1}$ (b) 5.7 m$s^{-1}$ (c) 3.82 m$s^{-1}$ (d) 2.86 m$s^{-1}$

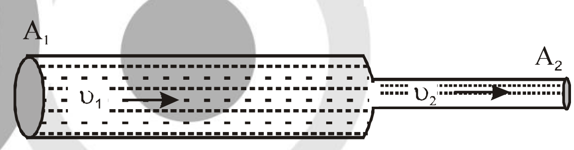
**C-5.** Water is flowing through a tube of non-uniform cross-section ratio of the radius at entry and exit end of the pipe is 3 : 2. Then the ratio of velocities at entry and exit of liquid is

(a) 4 : 9 (b) 9 : 4 (c) 8 : 27 (d) 1 : 1

**C-6.** Water is flowing through a horizontal pipe of non-uniform cross-section. At the extreme narrow portion of the pipe, the water will have

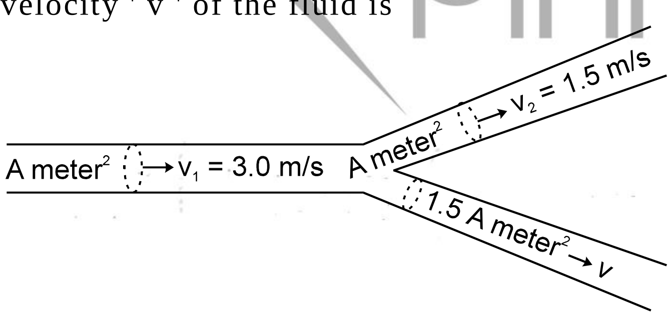
(a) Maximum speed and least pressure (b) Maximum pressure and least speed
(c) Both pressure and speed maximum (d) Both pressure and speed least

**C-7.** A liquid flows in a tube from left to right as shown in figure. A1 and A2 are the cross-section of the portions of the tube as shown. Then the ratio of speeds 1 /2 will be



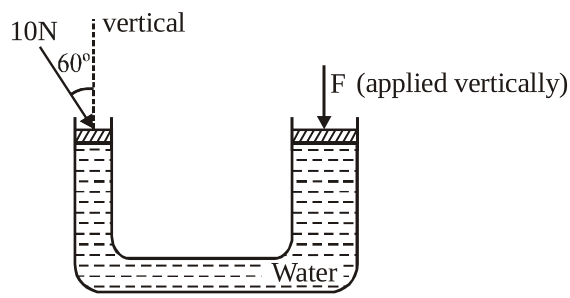

(a) $\frac{A_1}{A_2}$
(b) $\frac{A_2}{A_1}$
(c) $\sqrt{\frac{A_2}{A_1}}$
(d) $\sqrt{\frac{A_1}{A_2}}$

**C-8.** An incompressible liquid flows through a horizontal tube as shown in the figure. 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

**C-9.** The area of cross-section of the two vertical arms of a hydraulic press are 1 cm$^2$ and 10 cm$^2$ respectively. A force of 10 N applied, as shown in the figure, to a tight fitting light piston in the thinner arm balances a force F applied to the corresponding piston in the thicker arm. Assuming that the levels of water in both the arms are the same, we can conclude :



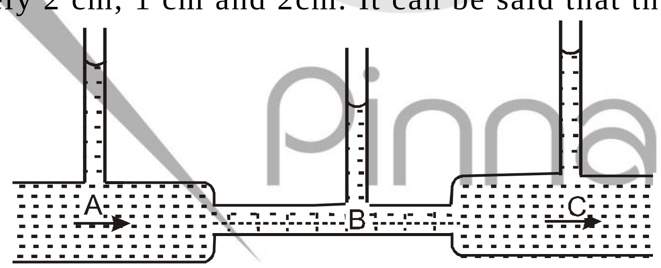

(a) F = 100 N (b) F = 50 N (c) F = 25 N
(d) F, as applied, cannot balance the effect of the force on the first piston.

## SECTION-D BERNOULLI THEOREM & ITS APPLICATION

**D-1.** Bernoulli's principle is based on the law of conservation of:
(a) mass (b) momentum (c) energy (d) none of these

**D-2.** Bernoulli's equation is applicable to points:
(a) in a steadily flowing liquid
(b) in a stream line
(c) in a straight line perpendicular to a stream line
(d) for ideal liquid stream line flow on a stream line

**D-3.** In the following flg. 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 2cm. 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 three tubes is the same
(d) Height of the liquid in the tubes A and C is the same

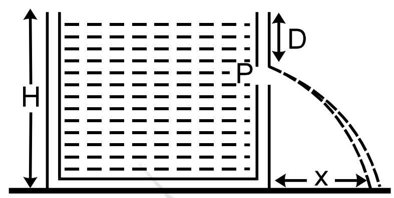
**D-4.** Air is steaming past a horizontal air plane wing such that its speed in 120 m/s over the upper surface and 90 m/s at the lower surface. If the density of air is 1.3 kg per metre3 and the wing is 10 m long and has an average width of 2 m, then the difference of the pressure on the two sides of the wing of
(a) 4095.0 Pascal (b) 409.50 Pascal (c) 40.950 Pascal (d) 4.0950 Pascal

**D-5.** 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
(a) 10 (b) 20 (c) 25.5 (d) 5

**D-6.** There is a hole in the bottom of tank having water. If total pressure at bottom is 3 atm ($1 \text{ atm} = 10^5 \text{ N}/m^2$) then the velocity of water flowing from hole is

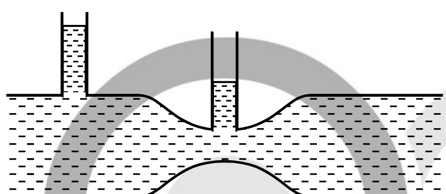
(a) $\sqrt{400}$ m/s (b) $\sqrt{600}$m/s (c) $\sqrt{60}$ m/s (d) None of these

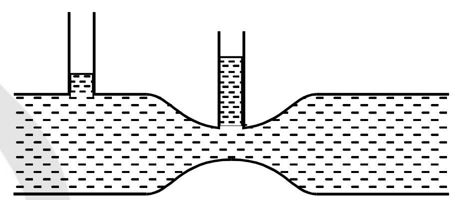
**D-7.** A tank is filled with water up to height H. Water is allowed to come out of a hole P in one of the walls at a depth D below the surface of water. Express the horizontal distance x in terms of H and D :

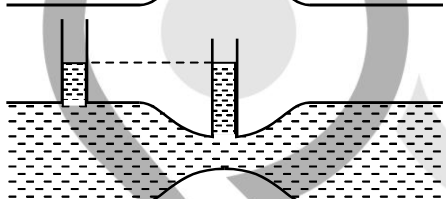


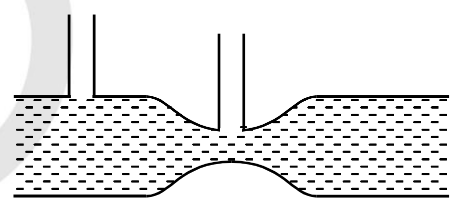

(a) $x = \sqrt{D(H-D)}$ (b) $x = \sqrt{\frac{D(H-D)}{2}}$ (c) $x = 2\sqrt{D(H-D)}$ (d) $x = 4\sqrt{D(H-D)}$

**D-8.** For a fluid which is flowing steadily, the level in the vertical tubes is best represented by

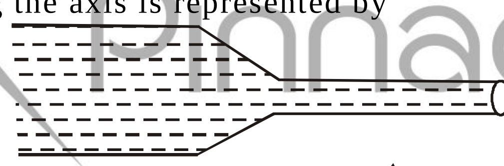
(a) 

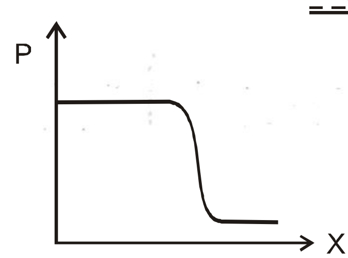
(b) 

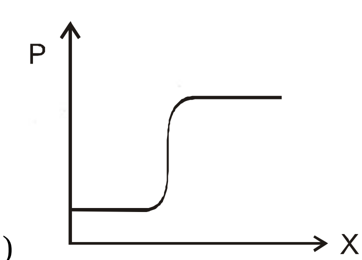
(c) 

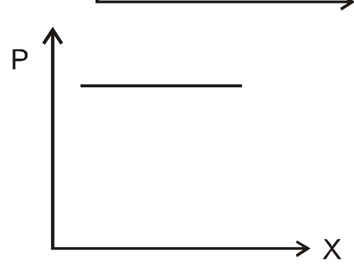
(d) 

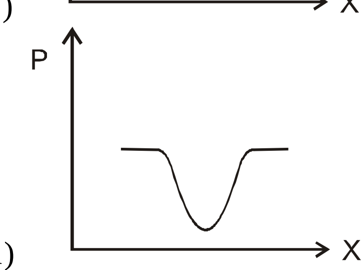
**D-9.** Water flows through a frictionless duct with a cross-section varying as shown in fig. Pressure p at points along the axis is represented by



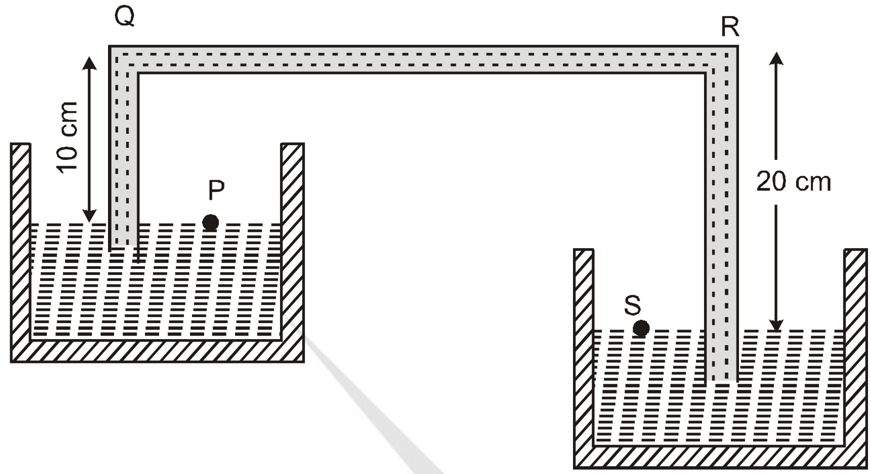
(a) 


(c) 


(c) 

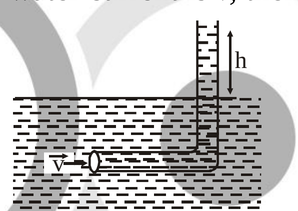

(d) 

**D-10.** A siphon in use is demonstrated in the following figure. The density of the liquid flowing in siphon is 1.5 gm/cc. The pressure difference between the point P and S will be




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

**D-11.** 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 :

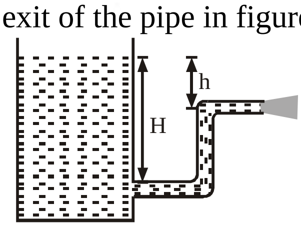



(a) The water in the tube rises to height $\frac{v^2}{2g}$
(b) The water in the tube rises to height $\frac{g}{2v^2}$
(c) The water in the tube does not rise at all
(d) None of these.

**D-12.** 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 holes are the same. Then Ris equal to :

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

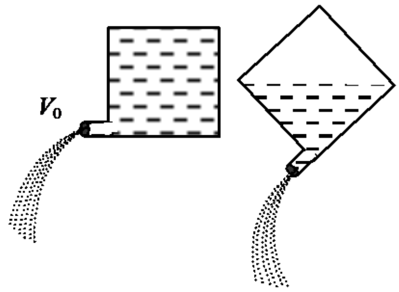
**D-13.** The discharge velocity at the exit of the pipe in figure shown is :




(a) $(2\rho H)^{\frac{1}{2}}$ (b) $(2gh)^{\frac{1}{2}}$ (c) $\{g(H+h)\}^{\frac{1}{2}}$ (d) 0

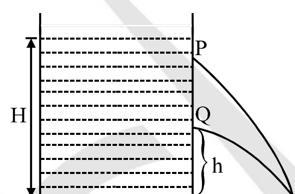
**D-14.** A cubical box of wine has a small spout located in one of the bottom corners. When the box is full and placed on a level surface, opening the spout result in a flow of wine with a initial speed of $v_0$ (see fig.) When the box is half empty, someone tilts it at 45°

so that the spout is at the lowest point. When the spout is opened the wine will flow out with a speed of :




(a) $v_0$ (b) $\frac{v_0}{2}$ (c) $\frac{v_0}{\sqrt{2}}$ (d) $\frac{v_0}{\sqrt[4]{2}}$

**D-15.** As shown in the figure water squirts horizontally out of two small holes in the side of the cylinder and the two streams strike the ground at the same point. If hole Q is at a height 'h' above ground and level of water stands to a height H, then the height of P above ground level is :




(a) 2h (b) H/h (c) (H – h) (d) None

**D-16.** Water is filled in a container upto height 3m. A small hole of area 'a' is punched in the wall of the container at a height 52.5 cm from the bottom. The cross sectional area of the container is A. If a/A = 0.1 then $v^2$ is (where v is the velocity of water coming out of the hole) (g = 10 m/s$^2$) :
(a) 50 (b) 55 (c) 45 (d) 52.5

**D-17.** An application of Bernoulli's equation for fluid flow is found in the :
(a) dynamic lift of an aeroplane (b) viscosity meter
(c) capillary rise (d) hydraulic

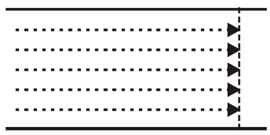
**SECTION-E TURBULENT AND LAMINAR FLOW**

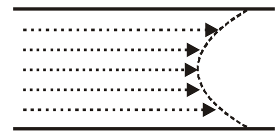
**E-1.** In a laminar flow the velocity of the liquid in contact with the wals of the tube is
(a) Zero (b) Maximum
(c) In between zero and maximum (d) Equal to critical velocity

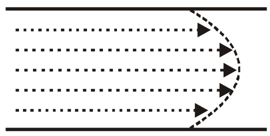
**E-2.** In a turbulent flow, the velocity of the liquid molecules in contact with the walls of the tube is –
(a) Zero (b) Maximum
(c) Equal to critical velocity (d) May have any value

**E-3.** The Reynolds number of a flow is the ratio of
(a) Gravity to viscous force (b) Gravity force to pressure force
(c) Inertial forces to viscous force (d) Viscous forces to pressure forces

**E-4.** 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

## SECTION-F VISCOSITY

**F-1.** An oil drop falls through air with a terminal velocity of $5\times10^{-4}$ m/s.
(i) the radius of the drop will be :
(a) $2.5\times10^{-6}$ m (b) $2\times10^{-6}$ m (c) $3\times10^{-6}$ m (d) $4\times10^{-6}$ m

(ii) the terminal velocity of a drop of half of this radius will be : (Viscosity of air = N-s/$m^2$. density of oil = 900 Kg/$m^3$. Neglect density of air as compared to that of oil)
(a) $3.25\times10^{-4}\frac{m}{s}$ (b) $2.10\times10^{-4}\frac{m}{s}$
(c) $1.5\times10^{-4}\frac{m}{s}$ (d) $1.25\times10^{-4}\frac{m}{s}$

**F-2.** The terminal velocity of a sphere moving through a viscous medium is :
(a) directly proportional to the radius of the sphere
(b) inversely proportional to the radius of the sphere
(c) directly proportional to the square of the radius of sphere
(d) inversely proportional to the square of the radius of sphere

**F-3.** A sphere is dropped gently into a medium of infinite extent. As the sphere falls, the force acting downwards on it
(a) remains constant throughout
(b) increases for sometime and then becomes constant
(c) decreases for sometime and then becomes zero
(d) increases for sometime and then decreases.

**F-4.** A solid sphere falls with a terminal velocity of 10 m/s in air. If it is allowed to fall in vacuum,
(a) terminal velocity will be more than 10 m/s
(b) terminal velocity will be less than 10 m/s
(c) terminal velocity will be 10 m/s
(d) there will be no terminal velocity

**F-5.** According to Newton, viscous force is given by
$F=\eta A\frac{dv}{dx}$
where $\eta$ = coefficient of viscosity, so dimensions of h will be :
(a) $[ML^{-1}T^{-2}]$ (b)$[MLT^{-2}]$ (c)$[ML^{-1}T^{-1}]$ (d) $[M^{-1}L^{2}T^{-2}]$

**F-6.** Spherical balls of radius R are falling in a viscous fluid of viscosity h with a velocity n. The retarding viscous force acting on the spherical ball is :
(a) directly proportional to R but inversely proportional to n

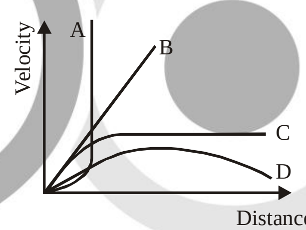
(b) directly proportional to both radius R and velocity n
(c) inversely proportional to both radius R and velocity n
(d) inversely proportional to R but directly proportional to n

**F-7.** If the terminal speed of a sphere of gold (density = 19.5 kg/$m^3$) is 0.2 m/s in a viscous liquid then find the terminal speed of sphere of silver (density = 10.5 kg/$m^3$) of the same size in the same liquid (density = 1.5 kg/$m^3$).
(a) 0.2 m/s (b) 0.4 m/s (c) 0.133 m/s (d) 0.1 m/s

**F-8.** A ball of mass 'm' and radius 'r' is released in viscous liquid. The value of its terminal velocity is proportional to :
(a) $\frac{1}{r}$ only (b) $\frac{m}{r}$ (c) $\left(\frac{m}{r}\right)^{\frac{1}{2}}$ (d) m only.

**F-9.** With increase in temperature the viscosity of :
(a) both gases and liquids increases
(b) both gases and liquids decreases
(c) gases increases and of liquids decreases
(d) gases decreases and of liquids increases

**F-10.** A small spherical solid ball is dropped in a viscous liquid. Its journey in the liquid is best described in the figure drawn by :




(A) curve A (B) curve B (C) curve C (D) curve D

**F-11.** A small drop of oil falls through air with a terminal velocity of $4 \times 10^{-4}$ m/s. Given that the viscosity of air is $1.8 \times 10^{-5}$ N-S/m$^2$, density of oil is 900 kg/m$^3$ and g = 10 m/s$^2$, and neglecting density of air in the calculation, the radius of the drop is :
(a) $0.55 \times 10^{-6}$ m (b) $1.9 \times 10^{-6}$ m
(c) $19 \times 10^{-6}$ m (d) $95 \times 10^{-6}$ m

**F-12.** Three observers on 10th, 5th and ground floor of a tall building measure the velocity of a certain rain drop by some accurate method. Surprisingly the velocity of rain drop measured by the observers is found to be the same. This is because :
(a) There is no gravitational force acting on the drop
(b) Gravitational force on the rain drop is balanced by force produced by surrounding air
(c) Gravitational force on the rain drop is balanced by the upward force of attraction produced by the cloud
(d) data is insufficient to predict

**F-13.** Viscosity is the property of a liquid due to which it :
(a) occupies minimum surface area
(b) opposes relative motion between its adjacent layers
(c) becomes spherical in shape
(d) tends to regain its deformed position

**F-14.** The C. G. S. unit of coefficient of viscosity is :
(a) poise (B) N-s/$m^2$ (C) dyne-sec/cm (D) g-sec/$cm^2$

**SECTION-G SURFACE TENSION AND SURFACE ENERGY**

**G-1.** Neglecting gravity, the potential energy of a molecule of liquid on the surface of liquid when compared with PE of a molecule inside liquid is :
(a) greater (b) less
(c) equal (d) depending on the liquid sometimes more, sometimes less

**G-2.** A thread is tied slightly loose to a wire frame as shown in the figure. And the frame is dipped into a soap solution and taken out. The frame is completely covered with the film. When the portion A is punctured with a pin, the thread :
(a) becomes convex towards A
(b) becomes concave towards A
(c) remains in the initial position
(d) either (1) or (2) depending on size of A w.r.t. B

**G-3.** The surface tension of a liquid is 5 newton per metre. If a film is held on a ring of area 0.02$metres^2$, its surface energy is about :
(a) $5\times10^{-2}$ J (b) $2.5\times10^{-2}$ J (c) $2\times10^{-1}$ J (d) $3\times10^{-1}$ J

**G-4.** Insects are able to run on the surface of water because :
(a) insects have less weight
(b) insects swim on water
(c) of the Archimede's upthrust
(d) surface tension makes the surface behave as elastic membrane.

**G-5.** At critical temperature, the surface tension of a liquid :
(a) is zero (b) is infinity
(c) is same as that at any other temperature (d) cannot be determined

**G-6.** The force required to drag a circular flat plate of radius 5 cm on the surface of water is (ST of water is 75 dyne/cm).
(a) 30 dyne (b) 60 dyne (c) 750 dyne (d) 750$\pi$ dyne

**G-7.** A 10 cm long wire is placed horizontally on the surface of water and is gently pulled up with a force of $2\times10^{-2}$ N to keep the wire in equilibrium. The surface tension, in N$m^{-1}$, of water is
(a) 0.1 (b) 0.2 (c) 0.001 (d) 0.002

**G-8.** The work done in increasing the size of a rectangular soap film with dimensions 8 cm ×3.75cm to 10 cm × 6 cm is $2\times10^{-4}$ J. The surface tension of the film in N/m is :
(a) $1.65\times10^{-2}$ (b) $3.3\times10^{-2}$ (c) $6.6\times10^{-2}$ (d) $8.25\times10^{-2}$

**G-9.** The property of surface tension is to :
(a) increase the volume (b) decrease the volume

(c) increase the surface area (d) decrease the surface area

**G-10.** Air is pushed into a soap bubble of radius r to double its radius. If the surface tension of the soap solution is S, the work done in the process is :
(a) $8\pi r^2 S$ (b) $12\pi r^2 S$ (c) $16\pi r^2 S$ (d) $24\pi r^2 S$

**G-11.** Liquid drops acquire spherical shape due to :
(a) gravity (b) surface tension
(c) viscosity (d) none of these

## SECTION-H EXCESS PRESSURE IN DROPS AND BUBBLE

**H-1.** If two soap bubbles of different radii are connected by a tube :
(a) air flows from the bigger bubble to the smaller bubble till the sizes become equal
(b) air flows from bigger bubble to the smaller bubble till the sizes are interchanged
(c) air flows from the smaller bubble to the bigger
(d) there is no flow of air

**H-2.** Work done in increasing the size of a soap bubble from a radius of 3 cm to 5 cm is nearly. (Surface tension of soap solution = 0.03 $Nm^{-1}$)
(a) 4π mJ (b) 0.2 π mJ (c) 2π mJ (d) 0.4π mJ

**H-3.** Two mercury drops (each of radius ' r') merge to from bigger drop. The surface energy of the bigger drop, if T is the surface tension, is :
(a) $4\pi r^2$ T (b) $2\pi r^2$ T (c) $2^{\frac{8}{3}}\pi r^2$ T (d) $2^{\frac{5}{3}}\pi r^2$ T

**H-4.** Excess pressure in a soap bubble of radius r is proportional to :
(a) $\frac{1}{r}$ (b) $\frac{1}{r^2}$ (c) r (d) $r^2$

**H-5.** As a bubble comes from the bottom of a lake to the top, its radius :
(a) Increases (b) Decreases (c) Does not change (d) Becomes zero.

**H-6.** The surface tension of soap solution is $25 \times 10^{-3}$ N/m . The excess pressure inside a soap bubble of diameter 1 cm is :
(a) 5 Pa (b) 10 Pa (c) 20 Pa (d) 40 Pa

## SECTION-I CAPILLARY ACTION

**I-1.** A liquid rises in a capillary tube when the angle of contact is :
(a) an acute one (b) an obtuse one (c) $\frac{\pi}{2}$ radian (d) π radian

**I-2.** The lower end of a capillary tube touches a liquid whose angle of contact is $90^0$, the liquid
(a) rises into the tube (b) falls in the tube
(c) may rise or fall inside (d) neither rises nor falls inside the tube

**I-3.** A capillary tube is filled with liquid up to a height of 50 cm. The reading when the capillary tube is tilted to an angle of $45^0$ is :
(a) 50 cm (b) $50\sqrt{2}$ cm (c) zero (d) none of these

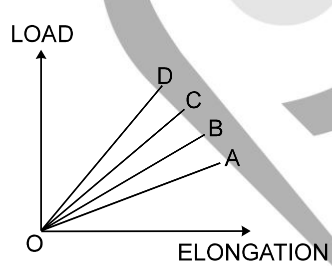
**I-4.** In a surface tension experiment with a capillary tube water rises upto 0.1 m. If the same experiment is repeated in an artificial satellite, which is revolving around the earth ; water will rise in the capillary tube upto a height of :
(a) 0.1 m (b) 0.2 m (c) 0.98 m (d) full length of tube

**I-5.** In a 18 cm long capillary tube water rises upto 16.3 cm height. If tube is cut at a height of 12 cm then:
(a) Water will eject out as fountain from capillary tube.
(b) Water will remain at 12 cm in capillary tube
(c) Height of water in capillary tube will be 10.3 cm
(d) Level of water will fall down from capillary tube

**SECTION-J ELASTIC BEHAVIOUR LONGITUDINAL STRESS, YOUNGS MODULUS**

**J-1.** The diameter of a brass rod is 4 mm and Young's modulus of brass is $9 \times 10^{10}$ N/m$^2$. The force required to stretch by 0.1% of its length is :
(a) $360\ \pi$ N (b) 36 N (c) $144\ \pi \times 10^3$ N (d) $36\ \pi \times 10^5$ N

**J-2.** The load versus elongation graph for four wires of the same materials is shown in the figure. The thinnest wire is represented by the line :




(a) OC (b) OD (c) OA (d) OB

**J-3.** The mean distance between the atoms of iron is $310^{-10}$m and interatomic force constant for iron is 7 N /m. The Yong's modulus of elasticity for iron is
(a) $2.33 \times 10^5$ N/ m$^2$ (b) $23.3 \times 10^{10}$ N/ m$^2$ (c) $233 \times 10^{10}$ N/ m$^2$ (d) $2.33 \times 10^{10}$ N/ m$^2$

**J-4.** According to Hooke's law of elasticity, if stress is increased, the ratio of stress to strain
(a) Increases (b) Decreases (c) Becomes zero (d) Remains constant

**J-5.** A particle moving on a straight line moves with a velocity of 10m/s for some time interval and with a velocity of 5 m/s for the same time interval. What is the average velocity of particle during the whole journey?
(a) 7.5 m/s (b) 3.33 m/s (c) 2.5 m/s (d) 1.67 m/s

**J-6.** An iron rod of length 2m and cross section area of 50mm$^2$ stretched by 0.5mm, when a mass of 250kg is hung from its lower end. Young's modulus of the iron rod is
(a) $19.6 \times 10^{10}$ N/ m$^2$ (b) $19.6 \times 10^{15}$ N/ m$^2$
(c) $19.6 \times 10^{18}$ N/ m$^2$ (d) $19.6 \times 10^{20}$ N/ m$^2$

**J-7.** A steel wire of 1 m long and 1 $mm^2$ cross section area is hang from rigid end. When weight of 1 kg is hung from it then change in length will be (given $Y = 2 \times 10^{11}$ N / $m^2$)
(a) 0.5 mm (b) 0.25 mm (c) 0.05 mm (d) 5 mm

**J-8.** The Young's modulus of a wire of length (L) and radius (r) is Y. If the length is reduced to $\frac{L}{2}$ and radius to $\frac{R}{2'}$ then its Young's modulus will be
(a) $\frac{Y}{2}$s (b) Y (c) 2Y (d) 2Y

**J-9.** A 5m aluminium wire ($Y = 7 \times 10^{10}$ N/$m^2$) of diameter 3 mm supports a 40 kg mass. In order to have the same elongation in a copper wire ($Y = 12 \times 10^{10}$ N/$m^2$) of the same length under the same weight, the diameter should be in mm
(a) 1.75 (b) 2.0 (c) 2.3 (d) 5.0

**J-10.** The following four wires are made of same material and same tension is applied on them. Which one will have maximum increase in length \?
(a) Length = 100 cm, Diameter = 1mm
(b) Length = 50 cm, Diameter = 0.5 mm
(c) Length = 200 cm, Diameter = 2mm
(d) Length = 300 cm, Diameter = 3 mm

## SECTION-K TENGENTIAL STRESS AND STRAIN, SHEAR MODULUS, BULK MODULUS

**K-1.** A square brass plate of side 1.0 m and thickness 0.005 m is subjected to a force F on its smaller opposite edges, causing a displacement of 0.02 cm. If the shear modulus of brass is $0.4 \times 10^{11}$ N/$m^2$, the value of the force F is
(a) $4 \times 10^3$ N (b) 400 N (c) $4 \times 10^4$ N (d) 1000 N

**K-2.** A metal block is experiencing an atmospheric pressure of $1 \times 10^5$ N/$m^2$, when the same block is placed in a vacuum chamber, the fractional change in its volume is (the bulk modulus of metal is $1.25 \times 10^{11}$ N/$m^2$)
(a) $4 \times 10^{-7}$ (b) $2 \times 10^{-7}$ (c) $8 \times 10^{-7}$ (d) $1 \times 10^{-7}$

## SECTION-L ELASTIC POTENTIAL ENERGY

**L-1.** If the potential energy of a spring is V on stretching it by 2 cm, then its potential energy when it is stretched by 10 cm will be :
(a) V/25 (b) 5 V (c) V/5 (d) 25 V

**L-2.** If work done in stretching a wire by 1mm is 2J, the work necessary for stretching another wire of same material, but with double the radius and half the length by 1mm in joule is -
(a) 1/4 (b) 4 (c) 8 (d) 16

**L-3.** Two wires of the same material and length but diameter in the ratio 1 : 2 are stretched by the same force. The ratio of potential energy per unit volume for the two wires when stretched will be :

(a) 1 : 1 (b) 2 : 1 (c) 4 : 1 (d) 16 : 1

**L-4.** Calculate the work done, if a wire is loaded by 'Mg' weight and the increase in length is '$\ell$'
(a) Mg$\ell$ (b) Zero (c) Mg$\ell$/2 (d) 2Mg$\ell$

**L-5.** An elastic material of Young's modulus Y is subjected to a stress S. The elastic energy stored per unit volume of the material is
(a) $\frac{2Y}{S^2}$ (b) $\frac{S^2}{2Y}$ (c) $\frac{S}{2Y}$ (d) $\frac{S^2}{Y}$

**L-6.** A stretched rubber has
(a) Increased kinetic energy (b) Increased potential energy
(c) Decreased kinetic energy (d) Decreased potential energy

**L-7.** If a spring extends by x on loading, then the energy stored by the spring is (if T is tension in the spring and k is spring constant)
(a) $\frac{T^2}{2x}$ (b) $\frac{T^2}{2k}$ (c) $\frac{2x}{T^2}$ (d) $\frac{2T^2}{k}$

**L-8.** On stretching a wire, the elastic energy stored per unit volume is
(a) F$\ell$/2AL (b) FA/2L (c) FL/2A (d) FL/2

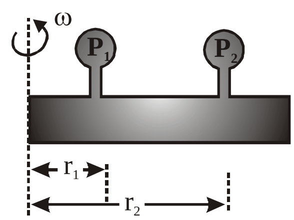
**L-9.** The elastic energy stored in a wire of Young's modulus Y is
(a) $Y \times \frac{Strain^2}{Volume}$ (b) Stress × Strain × Volume
(c) $\frac{Stress^2 \times Volume}{2Y}$ (d) Y × stress × Strain × Volume

**L-10.** A wire of length 50 cm and cross sectional area of 1 sq. mm is extended by 1 mm. The required work will be ($Y = 2 \times 10^{10}$ Nm$^{-2}$)
(a) $6 \times 10^{-2}$ J (b) $4 \times 10^{-2}$ J (c) $2 \times 10^{-2}$ J (d) $1 \times 10^{-2}$ J

**L-11.** A wire suspended vertically from one of its ends is stretched by attaching a weight of 200 N to the lower end. The weight stretches the wire by 1mm. Then the elastic energy stored in the wire is?
(a) 0.2 J (b) 10J (c) 20J (d) 0.1 J

## EXERCISE – II
### READY FOR CHALLENGES

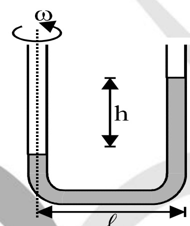
**1.** A tube filled with water of density ρ and closed at both ends uniformly rotates in a horizontal plane about a vertical axis. The monometers fixed in the tube at distances $r_1$ and $r_2$ from the axis indicate pressure $p_1$ and $p_2$ respectively. The angular velocity ω of rotation of the tube will be:




(a) $\omega = \sqrt{\frac{2}{\rho}\frac{(p_2 - p_1)}{(r_2{}^2 - r_1{}^2)}}$ (b) $\omega = \sqrt{\frac{2}{\rho}\frac{(p_2 + p_1)}{(r_2{}^2 + r_1{}^2)}}$

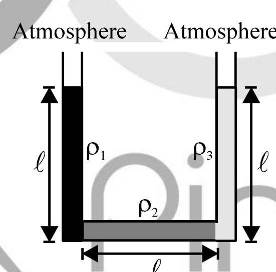
(c) $\omega = \sqrt{\frac{2}{\rho}\frac{p_2}{r_2{}^2} - \frac{p_1}{r_1{}^2}}$ (d) $\omega = \sqrt{\frac{2}{\rho}\left(\frac{p_2}{r_2} - \frac{p_1}{r_1}\right)}$ .

**2.** A U-tube of length $\ell$ contains a liquid. It is mounted on a horizontal turntable rotating with an angular speed ω about one of the arms. The difference in heights between the liquid columns in the vertical arm will be :



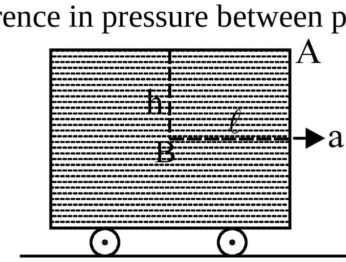

(a) $\frac{\omega^2 l^2}{2g}$ (b) $\frac{\omega^2 l^2}{g}$ (c) $\frac{\omega l^2}{2g}$ (d) $\frac{2\omega^2 l^2}{g}$

**3.** Three liquids having densities $\rho_1$, $\rho_2$ and $\rho_3$ are filled in a U-tube. Length of each liquid column is equal to $\ell$. $\rho_1 > \rho_2 > \rho_3$ and liquids remain at rest (relative to the tube) in the position shown in figure. It is possible that :



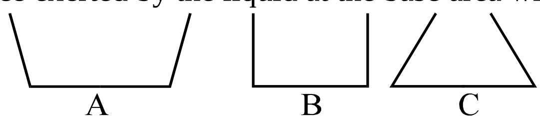

(a) U-tube is accelerating leftward.
(b) U-tube is accelerating upwards with acceleration g.
(c) U-tube is moving with a constant velocity
(d) None of these

**4.** A closed tank filled with water is mounted on a cart. The cart moves with an acceleration ‘a’ on a plane road. What is the difference in pressure between points B and A shown in figure ?



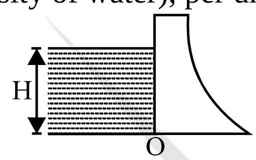

(a) hρg (b) (h + $\ell$)ρg (c) (hg + a$\ell$)ρ (d) (h – $\ell$)ρg

**5.** The three vessels shown in figure have same base area. Equal masses of a liquid are poured in each vessel. The force exerted by the liquid at the base area will be :



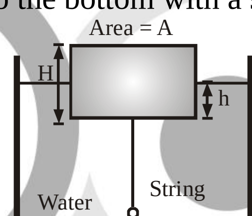

(a) equal in all vessels (b) maximum in vessel A
(c) maximum in vessel B (d) maximum in vessel C

**6.** Water stands to a depth H behind the vertical face of dam and exerts a certain resultant horizontal force on the dam and a certain torque tending to overturn the dam about the point O. What is the total torque about O (ρ = density of water), per unit width of dam?



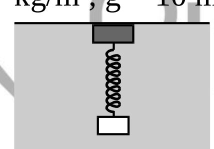

(a) $\frac{1}{6}\rho g H^3$ (b) $\rho g H^3$ (c) $\frac{1}{2}\rho g H^3$ (d) $\frac{1}{3}\rho g H^3$

**7.** A cylinderical body of cross-sectional area A, height H and density $\rho_s$, is immersed to depth h in a liquid of density ρ, and tied to the bottom with a string. The tension in the strip is :




(a) ρghA (b) $(\rho_s - \rho)$ghA (c) $(\rho - \rho_s)$ghA (d) $(\rho h - \rho_s H)$gA

**8.** A block of mass 10 kg, connected to another hollow block of same size and negligible mass, by a spring of spring constant 500 N/m, floats in water as shown in the figure. The compression in the spring is ($\rho_{water} = 1 \times 10^3$ kg/m³, g = 10 m/s²) ?

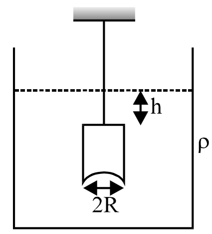


(a) 10 cm (b) 20 cm (c) 50 cm (d) 100 cm

**9.** What will be the height of liquid of the density 3.4 gm./cm$^3$ in the barometer at a place where it is 70 cm for mercury barometer ?
(a) 70 cm (b) 140 cm (c) 280 cm (d) none of the above

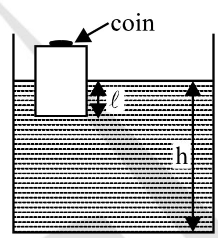
**10.** A metal cube is placed in an empty vessel. When water is filled in the vessel so that the cube is completely immersed in the water, the force on the bottom of the vessel in contact with cube :
(A) will increase (B) will decrease (C) will remain the same (D) will become zero

**11.** A hemispherical portion of radius R is removed from the bottom of a cylinder of radius R. The volume of the remaining cylinder is V and its mass M. It is suspended by a string in a liquid of density ρ where it stays vertical. The upper surface of the cylinder is at a depth h below the liquid surface. The force on the bottom of the cylinder by the liquid is :




(a) Mg (b) Mg – Vρg (c) $Mg+\pi R^2 h\rho g$ (d) $\rho g(V+\pi R^2 h)$

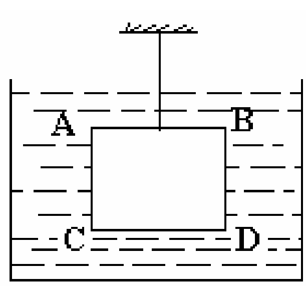
**12.** A wooden block, with a coin placed on its top, floats in water as shown in figure. The distance $\ell$ and h are shown here. After some time the coin falls into the water. Then :

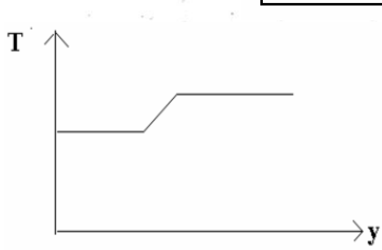


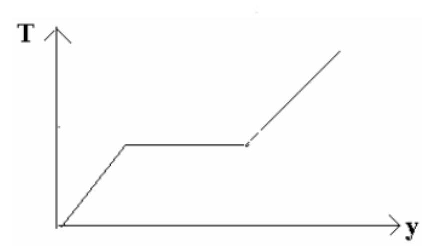

(a) $\ell$ decreases and h increases (b) $\ell$ increases and h decreases

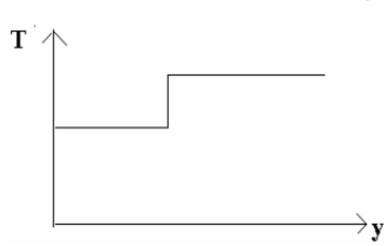
(c) both $\ell$ and h increases (d) both $\ell$ and h decrease

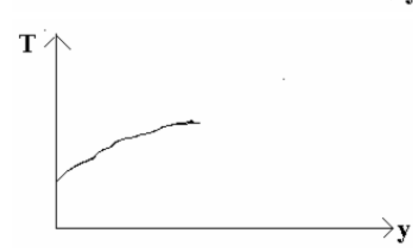
**13.** A metallic plate ABCD is suspended with a pair of sides horizontal by a light inelastic string as shown in the figure. A beaker of water is brought below the plate and raised till the plate is completely immersed and level of water is well above the plate. If the point of support slowly raised vertically with constant velocity. The variation of tension T in the string with the displacement y of point of support is best represented by :



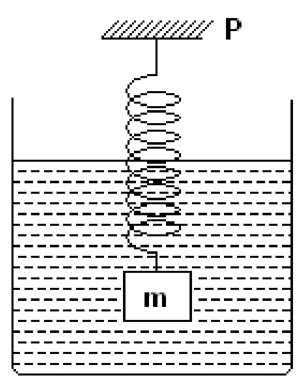

(a)



(b)



(c)



(d)


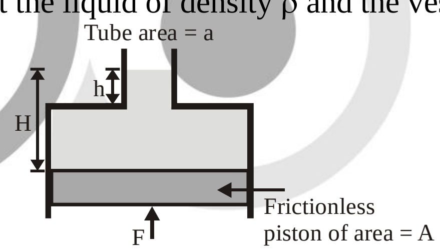
**14.** A cube of mass m and density D is suspended from the point P by a spring of stiffness K. The system is kept inside a beaker filled with a liquid of density d. The elongation in the spring is (take d < D) :




(a) $\frac{Mg}{K}\left(1-\frac{d}{D}\right)$ (b) $\frac{Mg}{K}\left(1-\frac{D}{d}\right)$ (C) (a) $\frac{Mg}{K}\left(1+\frac{d}{D}\right)$ (D) (a) $\frac{K}{Mg}\left(1-\frac{D}{d}\right)$

**15.** A small block of wood of density $0.4\times10^{3}$kg/m$^3$ is submerged in water and held at a depth of 3m. the time in which the block will rise to the surface when released, ignoring viscosity, is :
(a) 1.32s (b) 1.5s (c) 0.64s (d) 1s

**16.** The force F needed to support the liquid of density ρ and the vessel on top in figure is :




(a) $\rho g(ha-(H-h)A)$ (b) $\rho gHA$
(c) $\rho gHa$ (d) $\rho g(H-h)A$

**17.** Water from a tap emerges vertically downwards with an initial speed of 1.0 m/s. The cross-sectional area of the tap is $10^{-4}$m$^2$. Assume that the pressure is constant throughout the stream of water and that the flow is steady. The cross-sectional area of the stream 0.05 m below the tap is :
(a) $5.4\times10^{-4}$ m$^2$ (b) $1.7\times10^{-5}$ m$^2$ (c) $7.1\times10^{-5}$ m$^2$ (d) $2.3\times10^{-5}$ m$^2$

**18.** A flat plate moves normally toward a discharging jet of water at 3 m/s. The jet discharges the water at the rate of 0.1m$^3$/s and at a speed of 18 m/s. The force on the plate due to the jet is(Assume water loses its momentum on hitting the plate) :
(a) 2450N (b) 980 (c) 700N (d) 1800N

**19.** 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 H/n (n>1); and it takes $T_2$ time to take out the remaining water. If $T_1 = T_2$, then the value of n is :
(a) 2 (b) 3 (c) 4 (d) $2\sqrt{2}$

**20.** A fully loaded Boeing aircraft has a mass of $4.0 \times 10^5$ kg. Its total wing area is 500 $m^2$. It is in level flight with a speed of 1080 km/h. The pressure difference between the lower and upper surfaces of the wings :

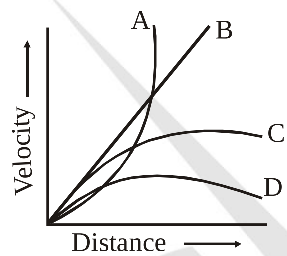
(a) 80 $N/m^2$ (b) $8.0 \times 10^3$ $N/m^2$

(c) $8.0 \times 10^4$ $N/m^2$ (d) $8.0 \times 10^5$ $N/m^2$

**21.** 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 ?

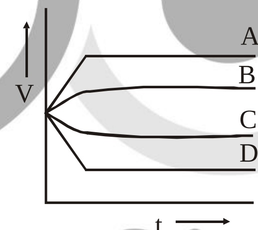
(a) 9 minutes (b) 7 minutes (c) 5 minutes (d) 3 minutes

**22.** A small spherical solid ball is dropped in a viscous liquid. Its journey in the liquid is best described in the figure shown by :




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

**23.** A small spherical solid ball is dropped from a height in a viscous liquid. At the time of entering into liquid, ball's velocity is greater than terminal velocity. Its journey in the liquid is best described in the figure.




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

**24.** A small ball of mass m and density $\rho_1$ was dropped in a jar filled with glycerine. Its velocity become constant after sometime. If the density of glycerine is $\rho_2$ , the viscous force acting on the ball is :

(a) $mg\left(\frac{\rho_2-\rho_1}{\rho_2}\right)$ (b) $mg\left(\frac{\rho_1-\rho_2}{\rho_1+\rho_2}\right)$ (c) $mg\left(\frac{\rho_1+\rho_2}{\rho_1-\rho_2}\right)$ (d) $mg\left(\frac{\rho_1-\rho_2}{\rho_1}\right)$

**25.** Two equal sized spherical raindrops are falling vertically through air terminal velocity 1 m/s . If the two drops combine to form a big single drop, then the terminal speed of this drop is :

(a) $2^{2/3}1$ (b) $2^{3/2}1$ (c) $2^{2/3}3$ (d) $2^{3/2}3$

**26.** A rain drop of radius r has a terminal velocity v m/s in air . The viscosity of air is η poise . The viscous force on it is F . If the radius of drop be 2r and the drop falls with terminal velocity in same air, the viscous force on it will be :

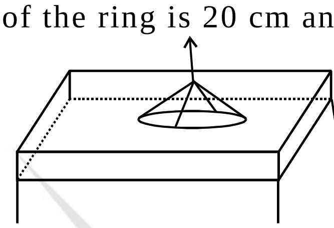
(a) F (b) F/2 (c) 4 F (d) 8 F

**27.** 0A spherical liquid drop of radius $R$ is divided into eight equal droplets. If surface tension is, $T$ then work done in the process will be :

(a) $2\pi R^2T$ (b) $3\pi R^2T$ (c) $4\pi R^2T$ (d) $2\pi T^2R$

**28.** The amount of work done in increasing the size of a soap film from 10×6 cm to 10×10 cm is : (S.T. = $30\times10^{-3}$ N/m)
(a) $2.4\times10^{-2}$J (b) $1.2\times10^{-2}$J (c) $2.4\times10^{-4}$J (d) $1.2\times10^{-4}$J

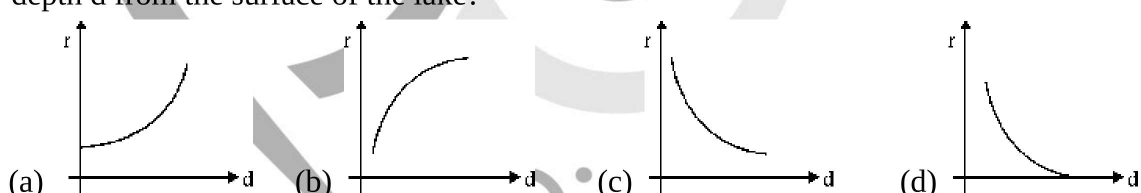
**29.** The surface tension of water is 75 dyne/cm. Find the minimum vertical force required to pull a thin wire ring up (refer figure) if it is initially resting on a horizontal water surface. The circumference of the ring is 20 cm and its weight is 0.1 N :



(a) 0.125 N (b) 0.225 N (c) 0.115 N (d) 0.130 N

**30.** A water drop of radius R is split into n drops each of radius r. If the surface tension of water is T, the energy required to split the drop is given by :
(a) $(4\pi r^2 n - 4\pi R^2)T$ (b) $\left[\left(4\pi r^2 n^{\frac{1}{3}}\right) - (4\pi R^2)\right]T$
(c) $(4\pi r^2 n - 4\pi R^2)nT$ (d) None

**31.** An air bubble rises from the bottom of a lake. Assuming the temperature of air bubble constant throughout, which of the following graph is most appropriate for the variation of its radius with the depth d from the surface of the lake?

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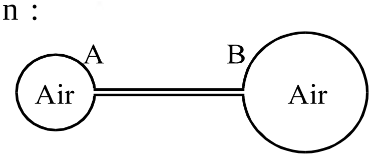
**32.** An air bubble of radius r in water is at a depth h below the water surface at some instant. If P is atmospheric pressure and d and T are the density and surface tension of water respectively, the pressure inside the bubble will be :
(a) $P + hdg - \frac{4T}{r}$ (b) $P + hdg + \frac{2T}{r}$ (c) $P + hdg - \frac{2T}{r}$ (d) $P + hdg + \frac{4T}{r}$

**33.** Two air bubbles A and B are connected by a tube as shown . The size of bubble A is smaller than that of B. Then :




(a) air flows from B to A till their sizes are equal
(b) air flows from B to A until the sizes or bubbles air interchanged
(c) air flows from A to B and B to A periodically
(d) air flows from A to B

**34.** A soap bubble of radius $r_1$ and another soap bubble of radius $r_2$ ($> r_1$) are brought together so that they have a common interface. The radius of the interface is :

(a) $r_2 - r_1$ (b) $2(r_2 - r_1)$ (c) $r_2 + r_1$ (d) $\frac{r_1 r_2}{r_2 - r_1}$

**35.** Two spherical soap bubbles of radii $r_1$ and $r_2$ in vacuum coalesce under isothermal conditions. The resulting bubble has a radius equal to :

(a) $\frac{r_1+r_2}{2}$ (b) $\frac{r_1 r_2}{r_2+r_1}$ (c) $\sqrt{r_1 r_2}$ (d) $\sqrt{r_1^2 + r_2^2}$

**36.** Two spherical soap bubbles of radii $r_1$ and $r_2$ coalesce together to form a single spherical bubble of radius r. If the atmospheric pressure is P0 and the surface tension is T, then :

(a) $P_0 = \frac{4T(r_1^2+r_2^2-r^2)}{(r^3-r_1^3-r_2^3)}$ (b) $P_0 = \frac{4T(r_1^2+r_2^2-r^2)}{(r^3-r_1^2-r_2^2)}$

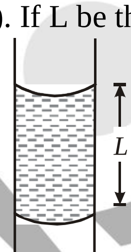
(c) $T = \frac{P_0(r_1^2+r_2^2-r^2)}{(r^3-r_1^2-r_2^2)}$ (d) $T = \frac{4P_0(r^2-r_1^2-r_2^2)}{(r_1^3-r_2^3+r^3)}$

**37.** A barometer contains two uniform capillaries of radii . If the height of liquid in the two tubes differ by $x$, and suface tension of liquid is $T$. Then the true pressure difference will be :

(a) $x\rho g$ (b) $x\rho g\left(\frac{R_1}{R_2}\right)$

(c) $2T\left[\frac{1}{R_1} - \frac{1}{R_2} d\right]$ (d) $x\rho g - 2T\left(\frac{1}{R_2} - \frac{1}{R_1}\right)$

**38.** A vertical glass capillary tube of radius r open at both ends contains some water (surface tension T and density ρ ). If L be the length of the water column, then :




(a) $L = \frac{4T}{r\rho g}$ (b) $L = \frac{2T}{r\rho g}$ (c) $L = \frac{T}{4r\rho g}$ (d) $L = \frac{T}{2r\rho g}$ .

**39.** On putting a capillary tube in a pot filled with water the level of water rises up to a height of 4 cm in the tube. If a tube of half the diameter is used, the water will rise to the height of nearly :

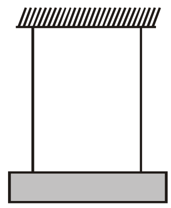
(a) 2 cm (b) 5 cm (c) 8 cm (d) 11 cm

## ELASTICITY

**40.** A steel wire is suspended vertically from a rigid support. When loaded with a weight in air, it expands by $L_a$ and when the weight is immersed completely in water, the extension is reduced to $L_w$. Then relative density of the material of the weight is:

(a) $\frac{L_a}{L_a - L_w}$ (b) $\frac{L_w}{L_a}$ (c) $\frac{L_a}{L_w}$ (d) $\frac{L_w}{L_a - L_w}$

**41.** Two wires of equal length and cross-section area suspended as shown in figure. Their Young's modulus are $Y_1$ and $Y_2$ respectively. The equivalent Young's modulus will be:



(a) $Y_1 + Y_2$ (b) $\frac{Y_1+Y_2}{2}$ (c) $\frac{Y_1 Y_2}{Y_1+Y_2}$ (d) $\sqrt{Y_1\,Y_2}$

**42.** A force F is needed to break a copper wire having radius R. The force needed to break a copper wire of radius 2 R will be :

(a) F/2 (b) 2 F (c) 4 F (d) F/4

**43.** A brass rod of length 2 m and cross-sectional area 2.0 $cm^2$ is attached end to end to a steel rod of length L and cross-sectional area 1.0 $cm^2$. The compound rod is subjected to equal and opposite pulls of magnitude $5 \times 10^4$ N at its ends. If the elongations of the two rods are equal, then length of the steel rod (L) is

($Y_{Brass} = 1.0 \times 10^{11}$ N/$m^2$ and $Y_{Steel} = 2.0 \times 10^{11}$ N/$m^2$ )

(a) 1.5 m (b) 1.8 m (c) 1 m (d) 2 m

**44.** The compressibility of water is $46.4 \times 10^{-6}$/atm. This means that

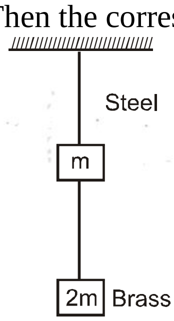
(a) the bulk modulus of water is $46.4 \times 10^6$ atm

(b) volume of water decreases by 46.4 one-millionths of the original volume for each atmosphere increase in pressure

(c) when water is subjected to an additional pressure of one atmosphere, its volume decreases by 46.4%

(d) When water is subjected to an additional pressure of one atmosphere, its volume is reduced to $10^{-6}$ of its original volume.

**45.** If the ratio of lengths, radii and Young's modulii of steel and brass wires in the figure are a, b, c respectively. Then the corresponding ratio of increase in their lengths would be :




(a) $\frac{2ac}{b^2}$ (b) $\frac{3a}{2b^2c}$ (c) $\frac{3c}{2ab^2}$ (d) $\frac{2a^2c}{b}$

**46.** Two identical rods in geometry but of different materials having co-efficients of thermal expansion $a_1$ and $a_2$ and Young's modulli $Y_1$ and $Y_2$ respectively are fixed between two rigid massive walls. The rods are heated such that they undergo the same increase in temperature. There is no bending of the rods. If $a_1 : a_2 = 2 : 6$ the thermal stresses developed in the two rods are equal provided $Y_1 : Y_2$ is equal to :

(a) 2 : 3 (b) 1 : 1 (c) 3 : 1 (d) 4 : 9

**47.** If a rubber ball is taken at the depth of 200 m in a pool its volume decreases by 0.1%. If the density of the water is $1 \times 10^3$ kg/m$^3$ and g = 10 m/s$^2$, then the volume elasticity in N/m$^2$ will be :
(a) $10^8$ (b) $2 \times 10^8$ (c) $10^9$ (d) $2 \times 10^9$

**48.** The breaking stress of a wire depends upon
(a) Length of the wire (b) Radius of the wire
(c) Material of the wire (d) Shape of the cross section

**49.** A wire of length 50 cm and cross sectional area of 1 sq. mm is extended by 1 mm. The required work will be (Y = $2 \times 10^{10}$ Nm$^{-2}$)
(a) $6 \times 10^{-2}$ J (b) $4 \times 10^{-2}$ J (c) $2 \times 10^{-2}$ J (d) $1 \times 10^{-2}$ J

**50.** Diameter of a brass rod is 4 mm and Young coefficient of elasticity is $9 \times 10^{10}$ N/m$^2$. Force required to increase the length of rod by 0.10% will be :
(a) 360 $\pi$N (b) 36 N (c) 144p $\times 10^3$ N (d) $36\pi \times 10^5$ N

**51.** A rubber ball is brought into 200 m deep water, its volume is decreased by 0.1% then volume elasticity coefficient of material of ball will be :
(a) $19.6 \times 10^8$ N/m$^2$ (b) $19.6 \times 10^{-10}$ N/m$^2$
(c) $19.6 \times 10^{10}$ N/m$^2$ (d) $19.6 \times 10^{-8}$ N/m$^2$

**52.** If poission ratio is 0.4 and after increasing the length of wire by 0.05% then decrease in its diameter will be :
(a) 0.02% (b) 0.1% (c) 0.01% (d) 0.4%

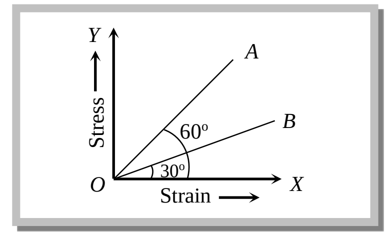
**53.** A tensile force F is applied on all six surfaces of a cube of side unity then increase in length of each side will be (Y = young measurement] $\sigma$ = Pieson ratio½
(a) $\frac{F}{Y(1-\sigma)}$ (b) $\frac{F}{Y(1+\sigma)}$ (c) $\frac{F(1-2\sigma)}{Y}$ (d) $\frac{F}{Y(1+2\sigma)}$

**54.** Copper of fixed volume 'V' is drawn into wire of length '$\ell$'. When this wire is subjected to a constant force 'F', the extension produced in the wire is '$\Delta\ell$'. Which of the following graph is a straight line?
(a) $\Delta\ell$ versus $1/\ell$ (b) $\Delta\ell$ versus $\ell^2$ (c) $\Delta\ell$ versus $1/\ell^2$ (d) $\Delta\ell$ versus $\ell$

**55.** A wire elongates by L mm when a load W is hanged from it. If the wire goes over a pulley and two weights W each are hung at the two ends, the elongation of the wire will be (in mm)
(a) L/2 (b) L (c) 2L (d) zero

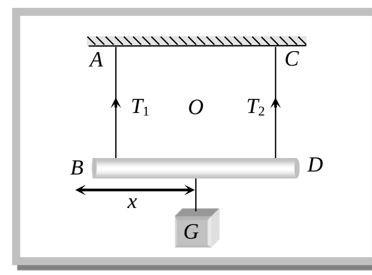
**56.** Two wires are made of the same material and have the same volume. However wire 1 has cross-sectional area A and wire 2 has cross-sectional area 3A. If the length of wire 1 increases by $\Delta x$ on applying force F, how much force is needed to stretch wire 2 by the same amount?
(a) 4F (b) 6F (c) 9F (d) F

**57.** The stress versus strain graphs for wires of two materials A and B are as shown in the figure. If YA and YB are the Young's modulii of the materials, then



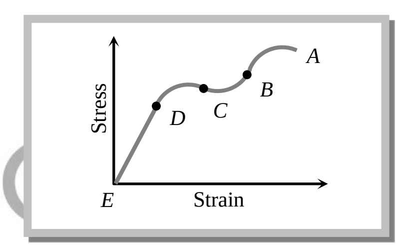

(a) $Y_B = 2Y_A$
(b) $Y_A = Y_B$
(c) $Y_B = 3Y_A$
(d) $Y_A = 3Y_B$

**58.** AB is an iron wire and CD is a copper wire of same length and same cross-section. BD is a rod of length 0.8 m. A load G = 2kg-wt is suspended from the rod. At what distance x from point B should the load be suspended for the rod to remain in a horizontal position
$(Y_{Cu} = 11.8 \times 10^{10}\ N/m^2, Y_{Fe} = 19.6 \times 10^{10}\ N/m^2)$



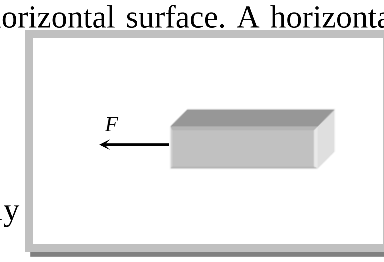

(a) 0.1 m
(b) 0.3 m
(c) 0.5 m
(d) 0.7 m

**59.** The figure shows the stress-strain graph of a certain substance. Over which region of the graph is Hooke's law obeyed




(a) AB
(b) BC
(c) CD
(d) ED

**60.** A uniform bar of square cross-section is lying along a frictionless horizontal surface. A horizontal force is applied to pull it from one of its ends then




(a) The bar is under same stress throughout its length
(b) The bar is not under any stress because force has been applied only
(c) The bar simply moves without any stress in it
(d) The stress developed reduces to zero at the end of the bar where no force is applied

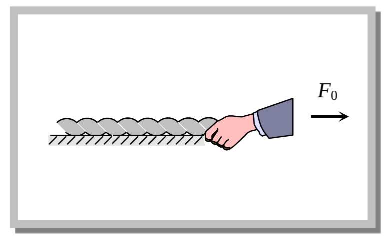
**61.** A constant force F0 is applied on a uniform elastic string placed over a smooth horizontal surface as shown in figure. Young's modulus of string is Y and area of cross-section is S. The strain produced in the string in the direction of force is

(a) $\frac{F_0 Y}{S}$

(b) $\frac{F_0}{SY}$

(c) $\frac{F_0}{2SY}$

(d) $\frac{F_0 Y}{2S}$




**62.** The compressibility of water is 4 × 10–5 per unit atmospheric pressure. The decrease in volume of 100 cubic centimetre of water under a pressure of 100 atmosphere will be

(a) 0.4 cc (b) $4\times10^{-5}\ cc$ (c) 0.025 cc (d) 0.004 cc

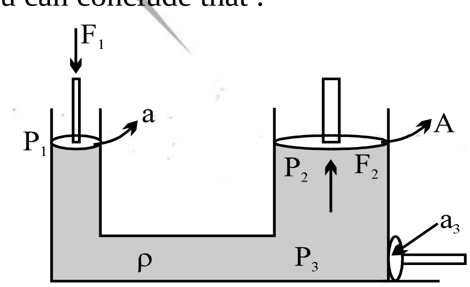
**63.** The end of a wire of length 0.5m and radius 10–3m is twisted through 0.80 radian. The shearing strain at the surface of wire will be

(a) $1.6\times10^{-3}$ (b) $1.6\times10^{3}$ (c) $16\times10^{3}$ (d) $16\times10^{6}$

## EXERCISE – III
## CROSSING THE HURDLES

**MORE THAN ONE CORRECT**

**1.** From the diagram you can conclude that :




(A) $AF_1 = aF_2$ (B) $P_1 = P_2 = P_3$ (C) $F_2 > F_1$ (D) $F_2 < F_1$

**2.** A beaker is filled in with water is accelerated a m/s² in +x direction. The surface of water shall make an angle :

(A) $\tan^{-1}\left(\frac{a}{g}\right)$ backwards (B) $\tan^{-1}\left(\frac{a}{g}\right)$ forwards

(C) $\cot^{-1}\left(\frac{g}{a}\right)$ backwards (D) $\cot^{-1}\left(\frac{g}{a}\right)$ forwards

**3.** Ice floats in water with about $\frac{9}{10}$th of its volume submerged. Then :

(A) On melting completely, no change in level is observed in gravity free space

(B) Volume submerged is independent of gravity

(C) On free fall, ice can float above water

(D) Temperature will increase

**4.** A weightless vessel is filled with a liquid of weight W and then placed on a weighing machine :

(A) The reading of machine must be equal to weight of liquid

(B) The reading of machine may be equal to weight of liquid

(C) The force exerted by liquid on base must to equal to reading

(D) The force exerted by liquid on base may to equal to reading

**5.** Water coming through a tube of cross-sectional area 10 $m^2$ with a speed of 5 m/s is allowed to come out through many holes of uniform cross-section 0.05 $m^2$. Then :

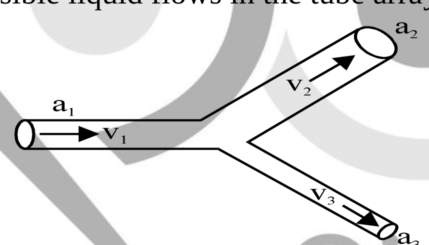
(A) Speed will be 10 m/s for 100 holes

(B) Speed will be 20 m/s for 50 holes

(C) Speed will be 5 m/s for 50 holes

(D) Rate of flow in each hole will become $\frac{1}{N}$ times the original flow.

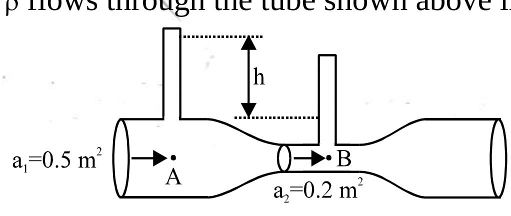
**6.** An incompressible liquid flows in the tube array as shown. Then :




(A) $a_2v_2 = 2a_1v_1$ for $a_2 = \frac{1}{2}a_1$ (B) $a_2v_2 + a_3v_3 = a_1v_1$

(C) $2a_2v_2 = a_1v_1$ for $a_2 = a_3$ (D) $a_3v_3 = a_2v_2$

**7.** As a liquid of density ρ flows through the tube shown above in a streamlined way. Then :



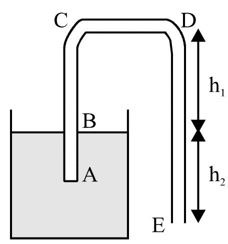

(A) Rate of flow reduces from $a_1$ to $a_2$.

(B) Rate of flow increases from $a_1$ to $a_2$.

(C) H is a measure of pressure difference at A and B

(D) Pressure A has to be more than that at B by hρg

**8.** In the siphon system shown below, v refers to velocity and P refers to pressure. Then :

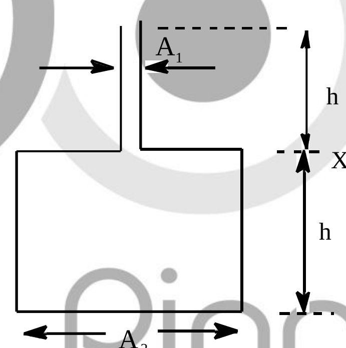



(A) $v_A = v_B = v_E = \sqrt{2gh_1}$
(B) $P_D = P_0 - \rho g(H_1 + H_2)$
(C) $v_E > v_A$
(D) $v_E = 5v_A + v_B$

**9.** Air is streaming past the wings of an aeroplane with a speed of 90 m/s below and 120 m/s above the surface. If the wing is 15 m long and has an average width of 2m, then : [Density of air = 1.2 kg/m3]
(A) Pressure difference is 4090 pascal
(B) Up-lift on the wing is 81900 Newton
(C) Up-lift on the wing is 113.4 K Newton
(D) Pressure difference is 3780 Pascal

**10.** Bernoulli's theorem can be applied to :
(A) Streamline flow
(B) non streamline and non viscous flow
(C) streamline and irrotational flow
(D) Streamline and rotational flow

**11.** Vessel shown in the figure has two sections of areas of cross section $A_1$ and $A_2$. A liquid of density ρ fills both sections up to a height h in each. Neglect atmospheric pressure.




(A) The pressure at the base of the vessel is 2hg
(B) The force exerted by the liquid on the base is 2hg.
(C) The weight of the liquid is less than 2hg.
(D) Walls of the vessel at the level x exert a downward force hg on the liquid.

**12.** A sphere is dropped under gravity through a viscous liquid of viscosity η. If the density of the material of sphere and liquid are ρ and σ respectively with the radius being 'r', then :
(A) Initial acceleration is $g\left(\frac{\rho-\sigma}{\rho}\right)$
(B) Time taken to attain terminal speed $t \, \alpha \, \sigma^0$
(C) At terminal speed, force on the sphere is zero
(D) At terminal speed, the viscous force is maximum

**13.** A rain drop reaching the ground with terminal velocity has momentum p. Another drop, twice the radius, also reaching the ground with terminal velocity, will have momentum & velocity :

(A) 4p, v (B) 8p, 4v (C) 32p, 4v (D) 16p, 2v

**14.** When large number of similar drops are merged together. Then :

(A) Surface energy decreases (B) Energy is evolved
(C) Energy is absorbed (D) Surface energy increases

**15.** Two air bubbles of radius $r_A$ and $r_B$ ($r_A > r_B$) formed of the same liquid come together to form a double bubble. Then, the radius at the common surface, r is related as :

(A) $r > r_A$ (B) $r > r_B$ (C) $r = r_A$ or $r_B$ (D) $r \neq r_A$ or $r_B$

**16.** Two soap bubbles ($\sigma$ – surface tension) of radii a and b are given (a < b) :

(A) The radius at the contact point is $\frac{1}{r} = \frac{1}{a} - \frac{1}{b}$

(B) The radius on merging them is $r = \sqrt{a^2 + b^2}$ under isothermal conditions.

(C) The new radius depends on atmospheric pressure

(D) The radius $r = \sqrt{\frac{a^2+b^2}{\sigma}}$

**17.** A capillary tube is immersed in a liquid. There will be :

(A) Ascent for angle of contact $\theta < 90^0$ (B) Ascent for angle of contact $\theta > 90^0$
(C) Descent for angle of contact $\theta > 90^0$ (D) Force of adhesion > Force of cohesion for $\theta > 90^0$

**18.** A glass capillary tube A of radius R is immersed in water and water rises to a height of 8 cm in it. Now, another tube B of radius 2R is immersed. There is a certain height difference between the water levels in them. (Density of water = $1000 kg/m^3$) Now the tubes are connected and dipped in water. Angle of contact $= 0^0$ ,

(A) When tube B was immersed in water, height of water level was 4cm

(B) Pressure difference due to surface tension, when tube B was immersed is $400 N/m^2$

(C) When tubes were connected and immersed, level difference in the tubes remain same as before.

(D) When tubes were connected and immersed in water, level difference in the tubes is 4 cm .

## COMPREHENSION TYPE QUESTION

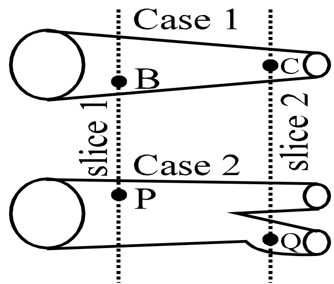
### PASSAGE I

Bernoulli's law and the continuity equation can help us understand some aspects of the circulatory systems. According to Bernoulli's law,

$$p_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = p_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$$

where p refers to the pressure, v refers to the speed, and h refers to the height of the fluid. The subscripts "1" and "2" refer to the fluid at two different points in the system.

According to the continuity equation, if a piece of the "pipeline" gets thicker, gets thinner or branches the volume of fluid per second passing two imaginary cross-sectional "slices" must be the same. For instance, in both cases drawn in figure 1, the volume of fluid per second passing slice 1 must equal the volume of fluid per second passing slice 2.




In case 1, the pipeline doesn't branch. In such cases, for essentially incompressible fluids, the continuity equation can be written

$$A_1v_1 = A_2v_2$$

Where A denotes the cross-sectional area of the pipe.

**19.** Consider case I : The blood at point B flows at 10 m/s. The blood at point C flows at a speed :

(A) greater than 10 m/s (B) equal to 10 m/s
(C) less than 10 m/s (D) impossible to determine from the information provided

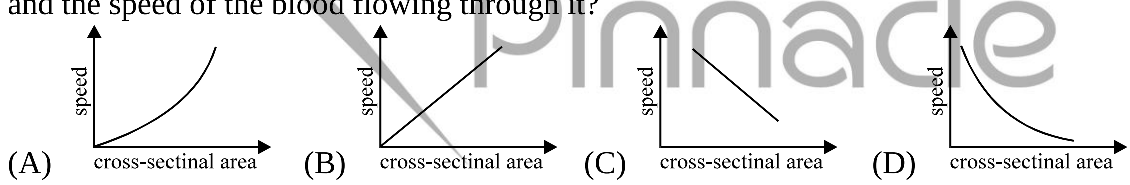
**20.** Consider case II : The blood at point P flows at speed 10 m/s. The blood at point Q flows at speed :

(A) greater than 10 m/s (B) equal to 10 m/s
(C) less than 10 m/s (D) impossible to determine from the information provided

**21.** Assume that the points B and C are at the same height. Let $p_B$ and $p_C$ denote the pressure at points B and C, respectively. Which of the following is true?

(A) $p_B > p_C$ (B) $p_B = p_C$ (C) $p_B < p_C$
(D) we cannot determine the relationship between $p_B$ and $p_C$

**22.** Suppose a blood vessel gets thinner, but doesn't "branch". Case I is an example. Which of the following graphs best shows the relationship between the cross-sectional area of the blood vessel and the speed of the blood flowing through it?




**PASSAGE II**

A liquid flowing from a vertical pipe has a very definite shape as it flows from the pipe. To get the equation for this shape, assume that the liquid is in free fall once it leaves the pipe. Just as it leaves the pipe, the liquid has speed $v_0$ and the radius of the stream of liquid is $r_0$.

**23.** An equation for the speed of the liquid as a function of the distance y it has fallen is :

(A) $v_2 = \sqrt{v_1^2 + 2a(y - y_0)}$ (B) $v_1 = \sqrt{v_2^2 + 2a(y - y_0)}$
(C) $v_2 = \sqrt{v_1^2 - 2a(y - y_0)}$ (D) $v_1 = \sqrt{v_2^2 + 2a(y - y_0)}$

**24.** Combining the above result with the equation of continuity the expression for radius of the stream as a function of y is :

(A) $r = \frac{r_0\sqrt{v_0}}{(v_0^2+2gy)^{1/2}}$ (B) $r = \frac{r_0\sqrt{v_0}}{(v_0^2+2gy)^{1/4}}$
(C) $r = (v_0^2 + 2gy)^{1/2}$ (D) $r = (v_0^2 + 2gy)^{1/4}$

**25.** If water flows out of a vertical pipe at a speed of 1.2 m/s, how far below the outlet will the radius be half the original radius of the stream?

(A) 110 m (B) 11 m (C) 1.1 m (D) 2 m

**PASSAGE III**

When liquid medicine of density ρ is to be put in the eye, it is done with the help of a dropper. As the bulb on the top of the dropper is pressed, a drop forms at the opening of the dropper. We wish to estimate the size of the drop. We first assume that the drop formed at the opening is spherical because that requires a minimum increases in its surface energy. To determine the size, we calculate the net vertical force due to the surface tension T when the radius of the drop is R. When this force becomes smaller than the weight of the drop, the drop gets detached from the dropper.

**26.** If the radius of the opening of the dropper is r, the vertical force due to the surface tension on the drop of radius R (assuming r << R) is

(A) 2πrT (B) 2πRT (C) $\frac{2\pi R^2 T}{R}$ (D) $\frac{2\pi R^2 T}{r}$

**27.** If $r = 5 \times 10^{-4}$m, $\rho = 10^3$ kg m$^{-3}$, g = 10 ms$^{-2}$, T = 0.11 Nm$^{-1}$, the radius of the drop when it detaches from the dropper is approximately.

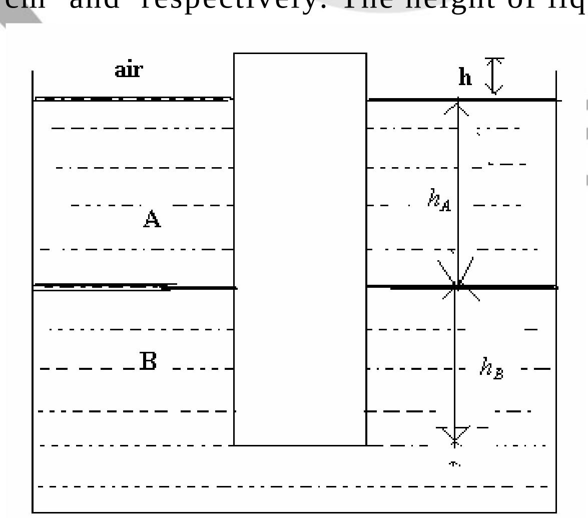
(A) $1.4 \times 10^{-3}$m (B) $3.3 \times 10^{-3}$m (C) $2.0 \times 10^{-3}$m (D) $4.1 \times 10^{-3}$m

**28.** After the drop detaches, its surface energy is

(A) $1.4 \times 10^{-6}$J (B) $2.7 \times 10^{-6}$J (C) $5.4 \times 10^{-6}$J (D) $8.1 \times 10^{-3}$J

**MATRIX MATCH TYPE**

**29.** Uniform solid cylinder at density $0.8 \text{gm}/cm^3$ floats equilibrium in a combination of two non mixing liquids A and B with its axis vertical. The densities of the liquids A and B are $0.7 \text{g/cm}^3$ and respectively. The height of liquid A and B are




| **Column-1** | **Column-II** |
|---|---|
| (A) net force exerted by liquids in region A on cylinder | (p)1.67 |
| (B) net force exerted by liquids B on cylinder | (q) 0.25 |
| (C) value of h (in cm) | (r) buoyancy force |
| (D) if cylinder is depressed in such a way that its | (s) zero |

top surface is just below the free surface of liquid and then released. Then the acceleration of the cylinder immediately after it is released. (in $m/s^2$)

**30.** **Column – I** **Column – II**

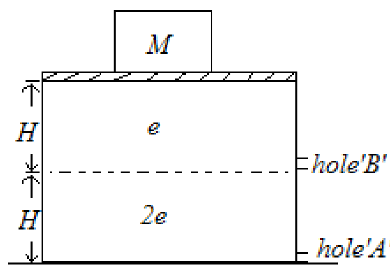
(A) Terminal velocity (p) Average density becomes less than that of liquid.

(B) Objects of high density can also float (q) Upthrust is zero

(C) A beaker having a solid iron under free fall (r) Varies with velocity

(D) Viscous drag (s) Upthrust and viscous force.

**31.** Along cylindrical tank of cross-sectional area A is filled with two immisible liquid of densities  and . It has two holes of cross section A/10; One is just above liquid interface (hole B) other one at the bottom (hole A) as shown in figure. A movable piston of cross-sectional area almost equal to 'A' is fitted on the top of the tank. A load kept on smooth horizontal surface.




**Column – I** **Column – II**

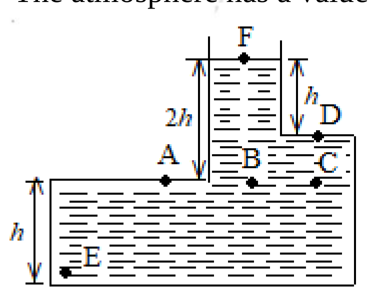
(A) Initial speed of water jet at hole A (p) $\sqrt{\frac{Mg}{eA}+3gH}$

(B) Initial speed of water jet at hole B (q) $\sqrt{\frac{2Mg}{eA}+2gH}$

(C) Maximum force exerted by water jet of hole A on the tank (r) $\frac{Mg}{5}+\frac{3eAHg}{5}$

(D) Maximum force exerted by water jet of hole B on the tank (s) $\frac{Mg}{5}+\frac{eAHg}{5}$

**32.** Consider a container filled with a liquid of density ρ. It shows different points A, B, C are along same horizontal line. The atmosphere has a value $P_{atm}$.




**Column – I** **Column–II**

(A) Pressure difference between A and F (p). zero

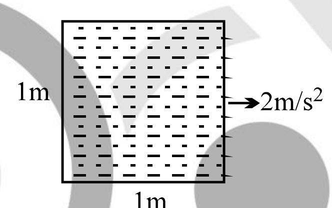
(B) Pressure difference between A and B (q). $\rho gh$

(C) Pressure difference between C and D (r). $3\rho gh$

(D) Gauge pressure at E (s) $2\rho gh$

## EXERCISE – IV

1. An open cubical tank completely filled with water is kept on a horizontal surface. Its acceleration is then slowly increased to $2m/s^2$ as shown in the Fig. The side of the tank is 1m. If the mass of water that would spill out of the tank is equal to 100/Nkg. Find the value of N.



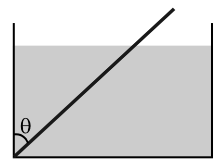

2. Two identical cylindrical vessels with their bases at the same level each contain a liquid of density $\rho$. The height of the liquid in one vessel is $h_1$ and in the other is $h_2$. The area of either base is A. What is the work done by gravity in equalising the levels when the two vessels are connected?

3. A solid ball of density half that of water falls freely under gravity from a height of 19.6 m and then enter water. How much time (in sec.) will it take to come again to the water surface? Neglect air resistance & velocity effects in water.

4. A solid block of volume $V=10^{-3}m^3$ and density $d=800kg/m^3$ is tied to one end of a string, the other end of which is tied to the bottom of the vessel. The vessel contains 2 immiscible liquids of densities
$\rho_1=1000kg/m^3$ and $\rho_2=1500kg/m^3$. The solid block is immersed with 2/5th of its volume in the liquid of higher density & 3/5th in the liquid of lower density. The vessel is placed in an elevator which is moving up with an acceleration of $a=g/2$. Find the tension in the string. [$g=10m/s^2$]

5. A solid sphere of radius 5cm floats in water. If a maximum load of 0.1kg can be put on it without wetting the load, find the specific gravity of the material of the sphere (in $\times 10^{-1}$)

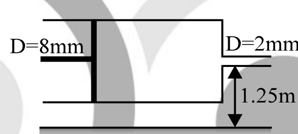
6. A wooden plank of length 1 m and uniform cross-section is hinged at one end to the bottom of a tank as shown in figure. The tank is filled with water upto a height 0.5 m. The specific gravity of the plank is 0.5. Find the angle $\theta$ that the plank makes with the vertical in the equilibrium position. (exclude the case $\theta = 0°$)




**7.** A wooden stick of length L, radius R and density ρ has a small metal piece of mass m (of negligible volume) attached to its one end. Find the minimum value for the mass m (in terms of given parameters) that would make the stick float vertically in equilibrium in a liquid of density $\sigma\ (> \rho)$.

**8.** A jet of water having velocity = 10 m/s and stream cross-section = 2 $cm^2$ hits a flat plate perpendicularly, with the water splashing out parallel to plate. If the plate experiences a force of $P \times 10$Newton. Find the value of P.

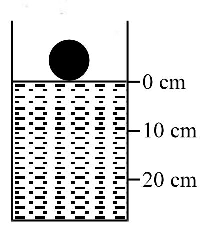
**9.** Consider a horizontally oriented syringe containing water located at a height of 1.25 m above the ground. The diameter of the plunger is 8 mm and the diameter of the nozzle is 2 mm. The plunger is pushed with a constant speed of 0.25 m/s. Find the horizontal range of water stream on the ground. (g = 10 $m/s^2$)




**10.** A cylindrical vessel open at the top is 20 cm high and 10 cm in diameter. A circular hole whose cross-sectional area 1 $cm^2$ is cut at the centre of the bottom of the vessel. Water flows from a tube above it into the vessel at the rate 100 $cm^3\ s^{-1}$. The height (in cm) of water in the vessel under steady state is (Take g = 1000 cm $s^{-2}$)

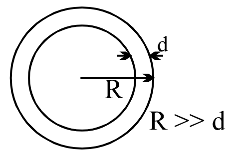
**11.** A spherical ball of density ρ and radius 0.003m is dropped into a tube containing a viscous fluid filled up to the 0 cm mark as shown in the figure. Viscosity of the fluid = 1.260 N.$m^{-2}$ and its density $\rho_L = \frac{\rho}{2}$ = 1260 kg.$m^{-3}$. Assume the ball reaches a terminal speed by the 10 cm mark. The time (in sec) taken by the ball to traverse the distance between the 10 cm and 20 cm mark is

( g = acceleration due to gravity = 10 $ms^{-2}$ )




**12.** A small sphere falls from rest in a viscous liquid. Due to friction, heat is produced. Find the relation between the rate of production of heat and the radius of the sphere at terminal velocity.

**13.** A soap bubble has radius R and thickness d (<< R) as shown. It colapses into a spherical drop. If the ratio of excess pressure in the drop to the excess pressure inside the bubble is equal to $\left(\frac{R}{N+6d}\right)^{\frac{1}{3}}$. Find the value of N.




**14.** Water having surface tension of 0.075J/m$^2$ is poured into a cylindrical vessel of radius 5cm. Find the surface energy possessed by it in $10^{-14}$J (nearly).

**15.** A long capillary tube of radius r is dipped in water such that $\sqrt{\frac{3}{4}}$ of the height it can rise in the capillary is available above the free level of water. The angle of contact at the top level in the tube is $\pi$/W. What is the value of W.

**16.** Two capillary tubes of equal length and inner radii 2r and 4r respectively, are added in series and a liquid flows through it. If the pressure difference between the ends of the whole system is 8.5cm of mercury, find out the pressure difference between the ends of the first capillary tube.

**17.** One end of a horizontal thick copper wire of length 2L and radius 2R is welded to an end of another horizontal thin copper wire of length L and radius R. When the arrangement is stretched by a applying forces at two ends, the ratio of the elongation in the thin wire to that in the thick wire is

**18.** A 1m long metal wire of cross sectional area $10^{-6}$ m$^2$ is fixed at one end from a rigid support and a weight W is hanging at its other end. The graph shows the observed extension of length $\Delta\ell$ of the wire as a function of W. Young's modulus of material of the wire in SI units is $m$ x $10^{11}$. What is the value of m.

## ANSWERS

### EXERCISE – I
### BUILDING A FOUNDATION

**SECTION-A**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| A-1. | (b) | A-2. | (b) | A-3. | (c) | A-4. | (c) |
| A-5. | (b) | A-6. | (d) | A-7. | (a) | A-8. | (b) |
| A-9. | (b) | A-10. | (b) | A-11. | (d) | | |

**SECTION-B**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| B-1. | (c) | B-2. | (b) | B-3. | (c) | B-4. | (b) |
| B-5. | (a) | B-6. | (c) | B-7. | (c) | B-8. | (b) |
| B-9. | (a) | B-10. | (d) | B-11. | (c) | B-12. | (c) |
| B-13. | (d) | B-14. | (a) | B-15. | (a) | B-16. | (a) |
| B-17. | (c) | B-18. | (b) | B-19. | (d) | B-20. | (b) |
| B-21. | (c) | B-22. | (a) | | | | |

**SECTION-C**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| C-1. | (a) | C-2. | (a) | C-3. | (d) | C-4. | (d) |
| C-5. | (a) | C-6. | (a) | C-7. | (b) | C-8. | (c) |
| C-9. | (b) | | | | | | |

**SECTION-D**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| D-1. | (c) | D-2. | (d) | D-3. | (b) | D-4. | (a) |
| D-5. | (b) | D-6. | (a) | D-7. | (c) | D-8. | (a) |
| D-9. | (a) | D-10. | (c) | D-11. | (a) | D-12. | (a) |
| D-13. | (b) | D-14. | (d) | D-15. | (c) | D-16. | (a) |
| D-17. | (a) | | | | | | |

**SECTION-E**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| E-1. | (a) | E-2. | (d) | E-3. | (c) | E-4. | (c) |

**SECTION-F**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| F-1. | (c,d) | F-2. | (c) | F-3. | (c) | F-4. | (d) |

| | | | |
|---|---|---|---|
| F-5. (c) | F-6. (b) | F-7. (d) | F-8. (b) |
| F-9. (c) | F-10. (c) | F-11. (b) | F-12. (b) |
| F-13. (b) | F-14. (a) | | |

**SECTION-G**

| | | | |
|---|---|---|---|
| G-1. (a) | G-2. (b) | G-3. (c) | G-4. (d) |
| G-5. (a) | G-6. (d) | G-7. (a) | G-8. (b) |
| G-9. (d) | G-10. (d) | G-11. (b) | |

**SECTION-H**

| | | | |
|---|---|---|---|
| H-1. (c) | H-2. (d) | H-3. (c) | H-4. (a) |
| H-5. (a) | H-6. (c) | | |

**SECTION-I**

| | | | |
|---|---|---|---|
| I-1. (a) | I-2. (d) | I-3. (b) | I-4. (d) |
| I-5. (b) | | | |

**SECTION-J**

| | | | |
|---|---|---|---|
| J-1. (a) | J-2. (c) | J-3. (d) | J-4. (d) |
| J-5. (a) | J-6. (a) | J-7. (c) | J-8. (b) |
| J-9. (c) | J-10. (b) | | |

**SECTION-K**

| | |
|---|---|
| K-1. (c) | K-2. (c) |

**SECTION-L**

| | | | |
|---|---|---|---|
| L-1. (d) | L-2. (d) | L-3. (d) | L-4. (c) |
| L-5. (b) | L-6. (b) | L-7. (b) | L-8. (a) |
| L-9. (c) | L-10. (c) | L-11. (d) | |

## EXERCISE – II
### READY FOR CHALLENGES

| | | | | |
|---|---|---|---|---|
| 1. (a) | 2. (a) | 3. (d) | 4. (c) | 5. (d) |
| 6. (a) | 7. (d) | 8. (a) | 9. (a) | 10. (c) |
| 11. (d) | 12. (d) | 13. (a) | 14. (a) | 15. (c) |
| 16. (b) | 17. (c) | 18. (A) | 19. (c) | 20. (b) |
| 21. (b) | 22. (c) | 23. (c) | 24. (d) | 25. (b) |
| 26. (d) | 27. (c) | 28. (c) | 29. (d) | 30. (b) |
| 31. (C) | 32. (b) | 33. (d) | 34. (d) | 35. (a) |
| 36. (a) | 37. (d) | 38. (a) | 39. (c) | 40.( a) |
| 41. (b) | 42. (c) | 43. (d) | 44. (b) | 45. (b) |

| | | | | |
|---|---|---|---|---|
| 46. (c) | 47. (d) | 48. (c) | 49. (c) | 50. (a) |
| 51. (a) | 52. (a) | 53. (c) | 54. (b) | 55. (b) |
| 56. (c) | 57. (d) | 58. (b) | 59. (d) | 60. (b) |
| 61. (c) | 62. (a) | 63. (a) | | |

## EXERCISE – III
## CROSSING THE HURDLES

**MORE THAN ONE CORRECT**

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

**MATCH THE COLUMN**

**29.** (A-s, B-r, C-q, D- p)
**30.** (A-s, B-p, C-q, D-r)
**31.** (A-p, B-q, C-r, D-s)
**32.** (A-s, B-p, C-q, D-r)

## EXERCISE – IV

| | | | | |
|---|---|---|---|---|
| 1. (4) | 2. (1) | 3. (2) | 4. (5) | 5. (4) |
| 6. (5) | 7. (6) | 8. (6) | 9. (6) | 10. (8) |

| 11. (8) |
|---|

12. $\frac{\rho A g}{4}(h_1 - h_2)^2$

13. $45^0$

14. $\pi R^2 L\sqrt{\rho\sigma - \rho}$

15. $\frac{dQ}{dt}$ **is proportional to** $r^5$

16. 2m

**1.** 1

**2.** $\frac{\rho A g}{4}(h_1 - h_2)^2$

**3.** 4

**4.** 6

**5.** 8

**6.** $45^0$

**7.** $\pi R^2 L\sqrt{\rho\sigma - \rho}$

**8.** 2

**9.** 2m

**10.** 5

**11.** 5

**12.** $\frac{dQ}{dt}$ **is proportional to** $r^5$

**13.** 4

**14.** **6**

**15.** **6**

**16.** **8**

**17.** 2

**18.** 2