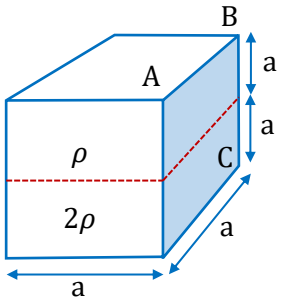
EXERCISE - O

SINGLE CORRECT TYPE QUESTIONS

Pressure and Pascal's law

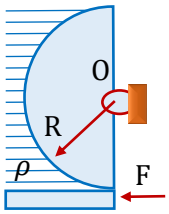
1. A cuboid ($a \times a \times 2a$) is filled with two immiscible liquids of density 2ρ and ρ as shown in the figure. Neglecting atmospheric pressure, ratio of force on base and side wall of the cuboid is:



(A) 2 : 3 (B) 1 : 3 (C) 5 : 6 (D) 6 : 5

PFM099

2. A light semi cylindrical gate of radius R is pivoted at its mid-point O, of the diameter as shown in the figure holding liquid of density ρ. The force F required to prevent the rotation of the gate is equal to



(A) $2\pi R^3\rho g$ (B) $2\rho g R^3 l$

(C) $\frac{2R^2 l\rho g}{3}$ (D) None of these

PFM102

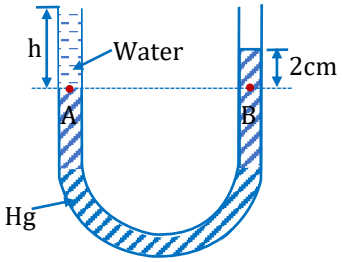
3. Some liquid is filled in a cylindrical vessel of radius R. Let F_1 be the force applied by the liquid on the bottom of the cylinder. Now the same liquid is poured into a vessel of uniform square cross-section of side R. Let F_2 be the force applied by the liquid on the bottom of this new vessel. (Neglect atmosphere pressure) Then:

(A) $F_1 = \pi F_2$ (B) $F_1 = \frac{F_2}{\pi}$

(C) $F_1 = \sqrt{\pi}\ F_2$ (D) $F_1 = F_2$

PFM168

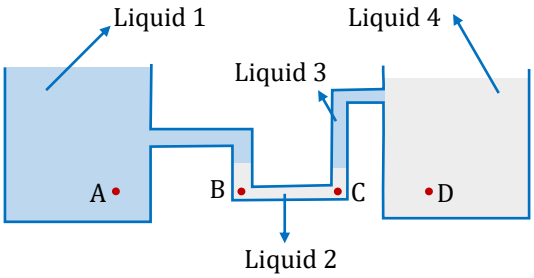
4. The liquids shown in figure in the two arms are mercury (density = 13.6 gm/cm^3) and water. If the difference of heights of the mercury column is 2 cm, find the height h of the water column:-



(A) 10 cm (B) 2 cm (C) 18 cm (D) 27.2 cm

PFM169

5. Which of the following is correct for the given diagram ? *A*, *B*, *C* and *D* are in same horizontal level.



(A) Pressure at *A* = Pressure at *B*
(B) Pressure at *B* = Pressure at *C*
(C) Pressure at *C* = Pressure at *D*
(D) All of the above

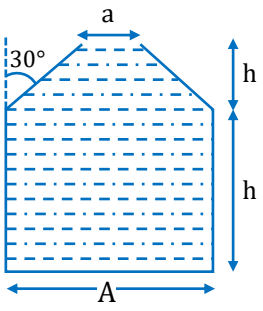
PFM170

6. Two identical cylindrical vessels are kept on the ground and each contain the same liquid of density ρ. The area of the base of both vessels is *S* but the height of liquid in one vessel is x_1 and in the other is x_2. When both cylinders are connected through a pipe of negligible volume very close to the bottom, the liquid flows from one vessel to the other until it comes to equilibrium at a new height. The change in energy of the system in the process is :

(A) $g\rho S\,(x_2 + x_1)^2$
(B) $\frac{3}{4}g\rho S(x_2 - x_1)^2$
(C) $\frac{1}{4}g\rho S(x_2 - x_1)^2$
(D) $g\rho S(x_2^2 + x_1^2)$

PFM171

7. The vessel shown in the figure has two sections. The lower part is a rectangular vessel with area of cross-section *A* and height *h*. The upper part is a conical vessel of height *h* with base area '*A*' and top area '*a*' and the walls of the vessel are inclined at an angle 30° with the vertical. A liquid of density ρ fills both the sections upto a height 2*h*. Neglecting atmospheric pressure.



(A) The force *F* exerted by the liquid on the base of the vessel is $2h\rho g\,\frac{(A+a)}{2}$.

(B) The pressure *P* at the base of the vessel is $2h\rho g\,\frac{A}{a}$.

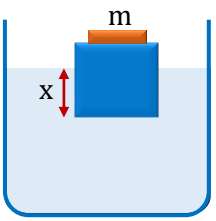
(C) The weight of the liquid *W* is greater than the force exerted by the liquid on the base.

(D) The walls of the vessel exert a downward force (*F* – *W*) on the liquid.

PFM172

Buoyancy

8. A cubical block ($a \times a \times a$), with a coin of mass 'm' over it is floating over a liquid of density ρ. In this case x_1 depth of the block is immersed. Now the coin is removed and it is found that x_2 depth is immersed in liquid. Value of $(x_1 - x_2)$ is :



(A) $\frac{m}{\rho a^2}$ (B) $\frac{\rho a^4}{m}$

(C) $\frac{m}{2\rho a^2}$ (D) Data insufficient

PFM106

9. An object of density d_o kept deep inside water of density d_w and released. During the time it moves a vertical distance h with in the water :-

(A) The gravitational potential energy of the water in the vessel increases if $d_0 < d_w$

(B) The gravitational potential energy of the water in the vessel decreases if $d_0 < d_w$

(C) The gravitational potential energy of the object increases if $d_0 > d_w$

(D) The gravitational potential energy of the object decreases if $d_0 < d_w$

PFM107

10. A long cylindrical vessel is half filled with a liquid. When the vessel is rotated about its own vertical axis, the liquid rises up near the wall. If the radius of vessel is 5 *cm* and its rotational speed is 2 rotations per second, then the difference in the heights between the centre and the sides, in *cm*, will be:

(A) 1.2 (B) 0.1 (C) 2.0 (D) 0.4

PFM108

11. Mercury is poured into a uniform vertical *U*-tube and water is poured in it. The level of water is the same in both arms. A piece of wood is dropped into one arm and some water, equal in weight to the piece of wood, is added to the other. Then, consider the statements:

(I) The level of mercury will be same in both the arms.

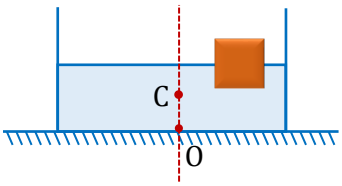
(II) The level of water will be same in both the arms.

(A) Both I and II are true (B) I is true but II is false

(C) I is false but II is true (D) Both I and II are false.

PFM109

12. There is water in container with center of mass at *C*. Now a small wooden piece is placed towards right as shown in the figure. After putting the wooden piece.



(A) Pressure at base remains same and centre of mass of water and wooden piece will be right of line *OC*.

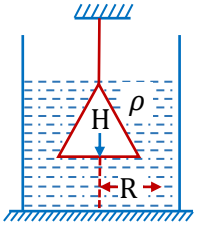
(B) Pressure at base remains same and centre of mass of water and wooden piece will be on line *OC*.

(C) Pressure at base changes and centre of mass of water and wooden piece will be right of line *OC*.

(D) Pressure at base changes and centre of mass of water and wooden piece will be on line *OC*.

PFM110

13. A cone of radius R and height H is hanging inside a liquid of density ρ by means of a string as shown in this figure. The force, due to the liquid acting on the slant surface of the cone is (Neglect atmosphere pressure)



(A) $\rho\pi gHR^2$ (B) $\pi\rho HR^2$

(C) $\pi\rho gHR^2$ (D) $\frac{2}{3}\pi\rho gHR^2$

PFM114

14. A heavy hollow cone of radius R and height h is placed on a horizontal table surface, with its flat base on the table. The whole volume inside the cone is filled with water of density ρ. The circular rim of the cone's base has a watertight seal with the table's surface and the top apex of the cone has a small hole. Neglecting atmospheric pressure find the total upward force exerted by water on the cone is

(A) $(2/3)\pi R^2h\rho g$ (B) $(1/3)\pi R^2h\rho g$ (C) $\pi R^2h\rho g$ (D) None

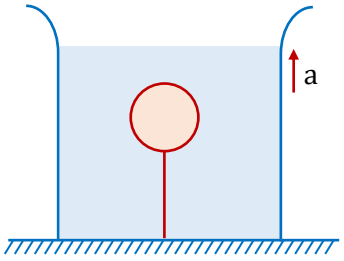
PFM115

15. A uniform cylinder of length L and mass M having cross-sectional area A is suspended, with its length vertical, form a fixed point by a massless spring, such that it is half submerged in a liquid of density σ at equilibrium position. The extension x_0 of the spring when it is in equilibrium is : (Here k is spring constant)

(A) $\frac{Mg}{k}$ (B) $\frac{Mg}{k}\left(1-\frac{LA\sigma}{M}\right)$ (C) $\frac{Mg}{k}\left(1-\frac{LA\sigma}{2M}\right)$ (D) $\frac{Mg}{k}\left(1+\frac{LA\sigma}{M}\right)$

PFM116

16. The tension in a string holding a solid block below the surface of a liquid (of density greater than that of solid) as shown in figure is T_0 when the system is at rest. What will be the tension in the string if the system has an upward acceleration a?



(A) $T_0\left(1+\frac{a}{g}\right)$ (B) $T_0\left(1-\frac{a}{g}\right)$

(C) $2T_0\left(1-\frac{a}{g}\right)$ (D) $3T_0\left(1+\frac{2a}{g}\right)$

PFM117

Fluid dynamics

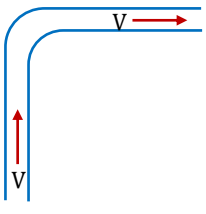
17. Two water pipes P and Q having diameters 2×10^{-2} m and $4\times10^{-2}m$, respectively, are joined in series with the main supply line of water. The velocity of water flowing in pipe P is :-

(A) 4 times that of Q (B) 2 times that of Q

(C) 1/2 times of that of Q (D) 1/4 times that of Q

PFM121

18. A fire hydrant delivers water of density ρ at a volume rate L. The water travels vertically upward through the hydrant and then does 90° turn to emerge horizontally at speed V. The pipe and nozzle have uniform cross-section throughout. The force exerted by the water on the corner of the hydrant is:-



(A) ρVL (B) zero

(C) $2\rho VL$ (D) $\sqrt{2}\rho VL$

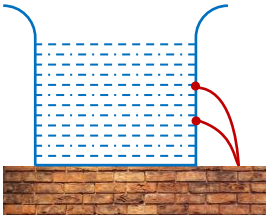
PFM122

19. Water is flowing steadily through a horizontal tube of non-uniform cross-section. If the pressure of water is $4 \times 10^4\ N/m^2$ at a point where cross-section is $0.02\ m^2$ and velocity of flow is $2\ m/s$, what is pressure at a point where cross-section reduces to $0.01\ m^2$.

(A) $1.4 \times 10^4\ N/m^2$ (B) $3.4 \times 10^4\ N/m^2$ (C) $2.4 \times 10^{-4}\ N/m^2$ (D) none of these

PFM123

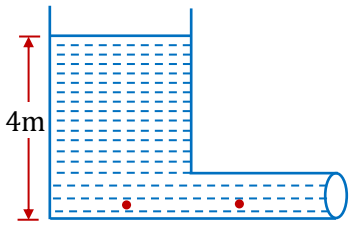
20. In a cylindrical vessel containing liquid of density ρ, there are two holes in the side walls at heights of h_1 and h_2 respectively such that the range of efflux at the bottom of the vessel is same. Find the height of a hole, for which the range of efflux would be maximum.



(A) $\left(\frac{h_1}{2}\right)$ (B) $\left(\frac{h_2}{2}\right)$ (C) $\left(\frac{h_2+h_1}{2}\right)$ (D) $(h_2 + h_1)$

PFM124

21. A vent tank of large cross-sectional area has a horizontal pipe $0.12\ m$ in diameter at the bottom. This holds a liquid whose density is $1500\ kg/m^3$ to a height of $4.0\ m$. Assume the liquid is an ideal fluid in laminar flow. In figure, the velocity with which fluid flows out is :-



(A) $2\sqrt{5}\ m/s$ (B) $\sqrt{5}\ m/s$ (C) $4\sqrt{5}\ m/s$ (D) $\sqrt{10}\ m/s$

PFM127

22. Calculate the rate of flow of glycerine of density $1.25 \times 10^3\ kg/m^3$ through the conical section of a pipe if the radii of its ends are $0.1\ m$ and $0.04\ m$ and the pressure drop across its length is $10\ N/m^2$.

(A) $(6.43 \times 10^{-4}\ m^3/s)$ (B) $(3.43 \times 10^{-4}\ m^3/s)$
(C) $(9.43 \times 10^{-4}\ m^3/s)$ (D) $(11.43 \times 10^{-4}\ m^3/s)$

PFM128

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

If $T_1 = T_2$, then the value of η is :

(A) 2 (B) 3 (C) 4 (D) 5

PFM132

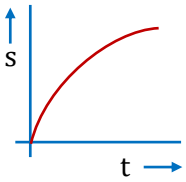
Viscosity

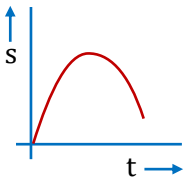
24. There is a $1mm$ thick layer of glycerine between a flat plate of area $100\ cm^2$ and a big fixed plate. If the coefficient of viscosity of glycerine is $1.0\ kg/m\text{-}s$ then how much force is required to move the plate with a velocity of $7\ cm/s$?

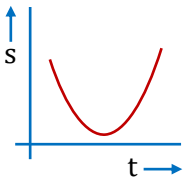
(A) $3.5\ N$ (B) $0.7\ N$ (C) $1.4\ N$ (D) None

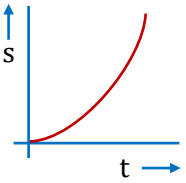
PFM138

25. The displacement of a ball falling from rest in a viscous medium is platted against time. Choose a possible option.

(A) 

(B) 

(C) 

(D) 

PFM139

26. An air bubble of radius 1cm is found to rise in a cylindrical vessel of large radius at a steady rate of 0.2 cm per second. If the density of the liquid is 1470 $kg\ m^{-3}$, then coefficient of viscosity of liquid is approximately equal to

(A) 163 poise (B) 163 centi-poise (C) 140 poise (D) 140 centi-poise

PFM140

27. If the terminal speed of a sphere of gold (density = 19.5 kg/m^3) is 0.2 m/s in a viscous liquid (density = 1.5 kg/m^3), find the terminal speed of a sphere of silver (density = 10.5 kg/m^3) of the same size in the same liquid.

(A) 0.4 m/s (B) 0.133 m/s (C) 0.1 m/s (D) 0.2 m/s

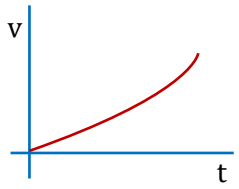
PFM141

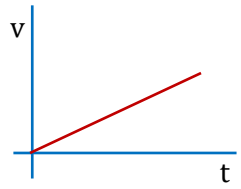
28. A solid metallic sphere of radius r is allowed to fall freely through air. If the frictional resistance due to air is proportional to the cross-sectional area and to the square of the velocity, then the terminal velocity of the sphere is proportional to which of the following?

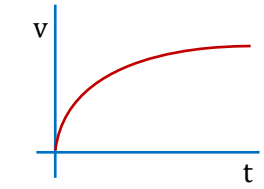
(A) r^2 (B) r (C) $r^{3/2}$ (D) $r^{1/2}$

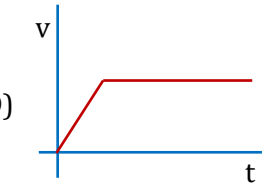
PFM145

29. Which of the following graphs best represents the motion of a raindrop?

(A) 

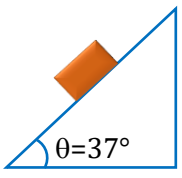
(B) 

(C) 

(D) 

PFM146

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



(A) $\frac{3\rho agt}{5v}$ (B) $\frac{4\rho agt}{5v}$

(C) $\frac{\rho agt}{v}$ (D) None of these

PFM147

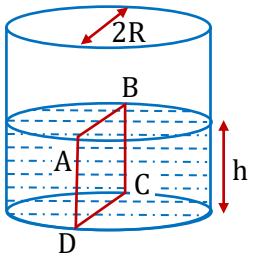
31. The Reynolds number for flow of a certain fluid in circular tube is specified as 2500. What will be the Reynolds number when the pipe diameter is increased by 20% and the fluid velocity is decreased by 40% keeping fluid the same?

(A) 200 (B) 1200 (C) 1800 (D) 3600

PFM148

Surface Tension

32. Water is filled up to a height h in a beaker of radius R as shown in the figure. The density of water is ρ, the surface tension of water is T and the atmospheric pressure is P_0. Consider a vertical section $ABCD$ of the water column through a diameter of the beaker. The force on water on one side of this section by water on the other side of this section has magnitude:



(A) $|2P_0Rh + \pi R^2\rho gh - 2RT|$ (B) $|2P_0Rh + R\rho gh^2 - 2RT|$

(C) $|P_0\pi R^2 + R\rho gh^2 - 2RT|$ (D) $|P_0\pi R^2 + R\rho gh^2 + 2RT|$

PFM149

33. Assume that a drop of liquid evaporates by decrease in its surface energy, so that its temperature remains unchanged. What should be the minimum radius of the drop for this to be possible? The surface tension is T, density of liquid is ρ and L is its latent heat of vaporization.

(A) $\frac{\rho L}{T}$ (B) $\sqrt{\frac{T}{\rho L}}$ (C) $\frac{T}{\rho L}$ (D) $\frac{2T}{\rho L}$

PFM153

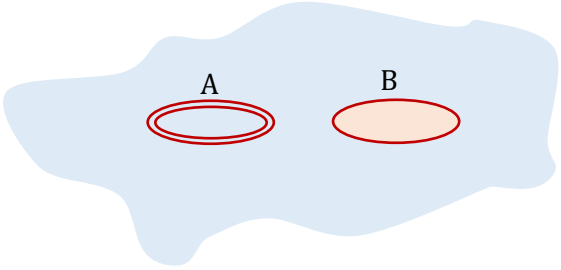
34. A small spherical droplet of density d is floating exactly half immersed in a liquid of density ρ and surface tension T. The radius of the droplet is

(Take note that the surface tension applies an upward force on the droplet)

(A) $r = \sqrt{\frac{2T}{3(d+\rho)g}}$ (B) $r = \sqrt{\frac{3T}{(2d-\rho)g}}$ (C) $r = \sqrt{\frac{T}{(d-\rho)g}}$ (D) $r = \sqrt{\frac{T}{(d+\rho)g}}$

PFM154

35. A rigid ring A and a rigid thin disk B both made of same material, when gently placed on water, just manage to float due to surface tension as shown in the figure. Both the ring and the disk have same radius. What can you conclude about their masses?



(A) Both have the same mass.

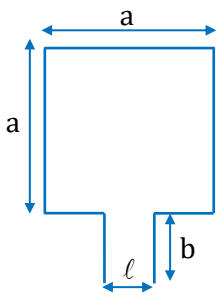
(B) Mass of the ring is half of that of the disk.

(C) Mass of the ring is double to that of the disk.

(D) More information is needed to decide.

PFM155

36. A light open rigid wire frame floats on the surface of water as shown in figure. What force will act on the frame, immediately after some soap solution is dropped inside it? α_1 and α_2 are the surface tensions of water and soap respectively ($\alpha_1 > \alpha_2$).



(A) Zero
(B) $(\alpha_1 - \alpha_2)\ell$
(C) $(\alpha_1 + \alpha_2)(4a + 2b + \ell)$
(D) $(\alpha_1 - \alpha_2)(4a + 2b - \ell)$

PFM156

37. If a drop of liquid breaks into smaller droplets, it results in lowering of temperature of the droplets. Let a drop of radius R, break into N small droplets each of radius r. Estimate the change in temperature.

(A) $\frac{2T}{\rho s}\left(\frac{1}{R}+\frac{1}{r}\right)$ (B) $\frac{4T}{\rho s}\left(\frac{1}{R}-\frac{1}{r}\right)$ (C) $\frac{3T}{\rho s}\left(\frac{1}{R}-\frac{1}{r}\right)$ (D) $\frac{2T}{\rho s}\left(\frac{1}{R}-\frac{1}{r}\right)$

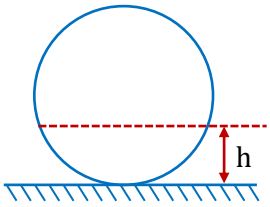
PFM157

38. When an air bubble rises from the bottom of a deep lake to a point just below the water surface, the pressure of air inside the bubble :-

(A) is greater than the pressure outside it (B) is less than the pressure outside it
(C) increases as the bubble moves up (D) remains same as the bubble moves up

PFM160

39. A liquid is filled in a spherical container of radius R till a height h. At this position the liquid surface at the edges is also horizontal. The contact angle is :-



(A) 0 (B) $\cos^{-1}\left(\frac{R-h}{R}\right)$ (C) $\cos^{-1}\left(\frac{h-R}{R}\right)$ (D) $\sin^{-1}\left(\frac{R-h}{R}\right)$

PFM161

40. An open capillary tube is lowered in a vessel with mercury. The difference between the levels of the mercury in the vessel and in the capillary tube $\Delta h = 4.6mm$. What is the radius of curvature of the mercury meniscus in the capillary tube? Surface tension of mercury is 0.46 N/m, density of mercury is 13.6 gm/cc.

(A) $\frac{1}{340}\,m$ (B) $\frac{1}{680}\,m$ (C) $\frac{1}{1020}\,m$ (D) Information insufficient

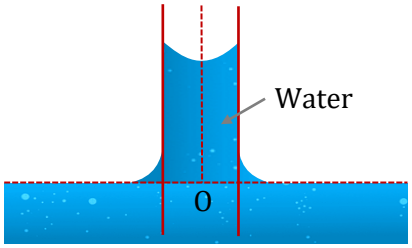
PFM162

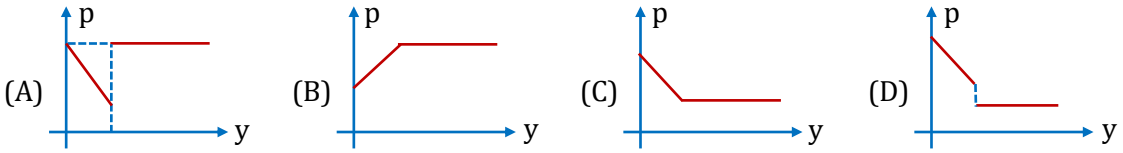
41. A container, whose bottom has round holes with diameter 0.1 mm is filled with water. The maximum height in cm upto which water can be filled without leakage will be what?
Surface tension = 75×10^{-3} N/m and $g = 10$ m/s^2:

(A) 20 cm (B) 40 cm (C) 30 cm (D) 60 cm

PFM163

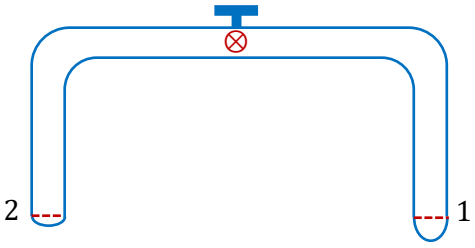
42. Water rises in a capillary as shown. The correct graph of pressure (p) vs height (y) above point O along the axis of capillary is :-





PFM164

43. A glass tube of uniform internal radius (r) has a valve separating the two identical ends. Initially, the valve is in a tightly closed position. End 1 has a hemispherical soap bubble of radius r. End 2 has sub-hemispherical soap bubble as shown in figure. Just after opening the valve



(A) air from end 1 flows towards end 2. No change in the volume of the soap bubbles.

(B) air from end 1 flows towards end 2. Volume of the soap bubble at end 1 decreases.

(C) no change occurs.

(D) air from end 2 flows towards end 1. Volume of the soap bubble at end 1 increases.

PFM165

MULTIPLE CORRECT TYPE QUESTIONS

Pressure and Pascal's law

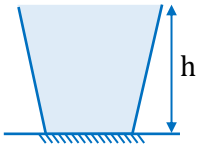
44. M gm of a liquid of density ρ is filled in a light beaker and kept on a horizontal table as shown in the figure. The height of the liquid in the beaker is h. The beaker is wider on top than at its base and the cross-sectional area of the base is A. Neglect the effect of atmospheric pressure. Now,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

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

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

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

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



PFM100

45. A beaker is filled in with water is accelerated by $a\ m/s^2$ in + x direction. The surface of water shall make an angle.

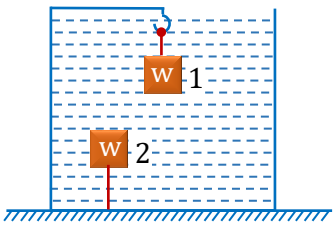
(A) $\tan^{-1}(a/g)$ backwards (B) $\tan^{-1}(a/g)$ forwards

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

PFM101

Buoyancy

46. An iron block and a wooden block are positioned in a vessel containing water as shown in the figure. The iron block (1) hangs from a massless string with a rigid support from the top while the wooden block (2) floats being tied to the bottom through a massless string. If now the vessel starts acceleration towards right.



(A) Iron block gets deflected towards right.

(B) Wooden block gets deflected towards right.

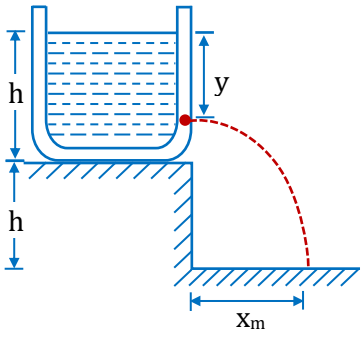
(C) Iron block gets deflected towards left.

(D) Wooden block gets deflected towards left.

PFM119

Fluid dynamics

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



(A) $x_m = 2h$ (B) $x_m = 1.5\ h$ (C) $y = h$ (D) $y = 0.75\ h$

PFM129

48. A tube of small uniform cross section is used to siphon the water from the vessel. Then choose correct alternative(s) :

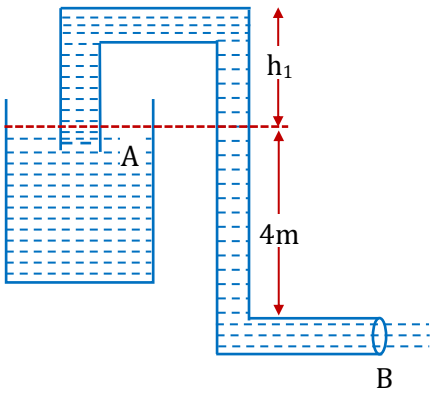
($\rho_{water} = 10^3\ kg/m^3, g = 10\ m/s^2, P_{atm} = 10^5\ Pa$)

(A) Water will come out from section B with a velocity of $\sqrt{80}\ m/s$

(B) Water will come out from section B with a velocity of $10\sqrt{2}\ m/s$

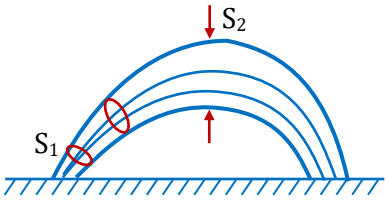
(C) The greatest value of h_1 for which the siphon will work is $10\ m$

(D) The greatest value of h_1 for which the siphon will work is $6\ m$



PFM131

49. Water jet is projected to an angle to the horizontal. At the point of projection, the area of the jet is S_1 and at the highest point, the are of the jet is S_2. The initial velocity of projection is u.



(A) The angle of projection is $\cos^{-1}\left(\frac{S_1}{S_2}\right)$

(B) The range of the level ground is $\frac{2u^2}{g}\frac{S_1}{S_2}\sqrt{1-\frac{S_1^2}{S_2^2}}$

(C) The maximum height reached from the ground is $\frac{2u^2}{g}\left(1-\frac{S_1^2}{S_2^2}\right)$

(D) The rate of volume flow is S_2u.

PFM136

Surface Tension

50. n drops of a liquid, each with surface energy E, joining to form a single drop

(A) some energy will be released in the process

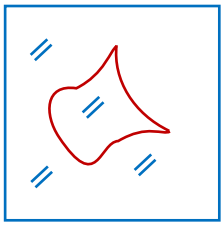
(B) some energy will be absorbed in the process

(C) the energy released or absorbed will be $E(n-n^{2/3})$

(D) the energy released or absorbed will be $nE(n^{2/3}-1)$

PFM158

51. A soap film (surface tension = T) is formed on a rectangular wire frame as shown in figure. A small, film in the irregular fashion in which it was placed. Now, a hole is pricked in the film. The loop stays on the film in the irregular fashion in which it was placed. Now, a hole is pricked in the film inside the loop with a needle and the thread finally comes to equilibrium position. Choose the correct option(s):



(A) The thread will take a square shape

(B) The thread will take a circular shape

(C) Tension in the thread will be $2T\ell$

(D) Tension in the thread will be $\frac{T\ell}{\pi}$

PFM159

COMPREHENSION TYPE QUESTIONS

Surface Tension

PARAGRAPH FOR QUESTION NO. 52 TO 54

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 increase 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.

52. 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) $2\pi rT$ (B) $2\pi RT$ (C) $\frac{2\pi r^2 T}{R}$ (D) $\frac{2\pi R^2 T}{r}$

PFM150

53. If $r = 5 \times 10^{-4}\ m$, $\rho = 10^3\ kgm^{-3}$, $g = 10\ ms^{-2}$, $T = 0.11\ Nm^{-1}$, 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) $4.1 \times 10^{-3}\ m$

PFM151

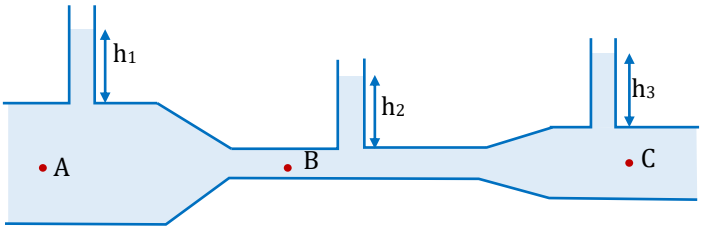
54. After the drop detaches, its surface energy is

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

PFM152

MATRIX MATCH TYPE QUESTION

55. An ideal liquid is flowing in a tube as shown in figure. Area of cross-section at points A, B and C are A_1, A_2 and A_3 respectively ($A_1 > A_3 > A_2$). v_1, v_2,$>v_3$ are the velocities at the points A, B and C respectively.



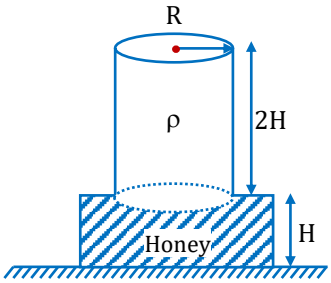
Column-I	**Column-II**
(A) h_1 is	(P) Less than h_3
(B) h_2 is	(Q) More than h_3
(C) v_1 is	(R) Less than v_3
(D) v_2 is	(S) More than v_3
	(T) The maximum value amongst the three velocities

(A) (A-P), (B-Q), (C-S,T), (D-R)
(B) (A-R), (B-Q), (C-P), (D-T,S)
(C) (A-Q), (B-P), (C-R), (D-S,T)
(D) (A-S,T), (B-Q), (C-P), (D-R)

PFM180

MISCELLANEOUS QUESTION

56. A bottle is kept on the ground as shown in the figure. The bottle can be modelled as having two cylindrical zones. The lower zone of the bottle has a cross-sectional radius if $R\sqrt{2}$ and is filled with honey of density 2ρ. The upper zone of the bottle is filled with the water of density ρ and has a cross-sectional radius R. The height of the lower zone is H while that of the upper zone is $2H$. If now the honey and the water parts are mixed together to form a homogeneous solution: (Assume that total volume does not change)



(A) The pressure inside the bottle at the base will remain unaltered.

(B) The normal reaction on the bottle from the ground will remain unaltered

(C) The pressure inside the bottle at the base will increase by an amount $\left(\frac{1}{2}\right)\rho gH$

(D) The pressure inside the bottle at the base will decrease by an amount $\left(\frac{1}{4}\right)\rho gH$

PFM173

57. A solid sphere of radius R and density ρ is attached to one end of a mass-less spring of force constant k. The other end of the spring is connected to another solid sphere of radius R and density 3ρ. The complete arrangement is placed in a liquid of density 2ρ and is allowed to reach equilibrium. The correct statement(s) is (are):

(A) The net elongation of the spring is $\frac{4\pi R^3\rho g}{3k}$

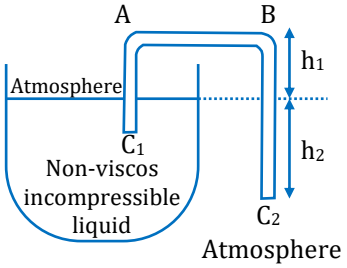
(B) The net elongation of the spring is $\frac{8\pi R^3\rho g}{3k}$

(C) The light sphere is partially submerged.

(D) The light sphere is completely submerged.

PFM174

58. An evacuated thin tube has two tight caps C_1 and C_2 at its ends. The tube is adjusted as shown in the figure below. Atmospheric pressure = P and density of the liquid = d, Neglect surface tension of liquid. Match the entities of columns.

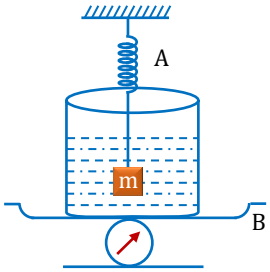


	List-I		List-I
(P)	$h_1 > \frac{P}{dg}, h_2 = 0$	(1)	If C_2 is opened first and then C_1 is opened, liquid level in the left arm of the tube will be on level with liquid in the pot.
(Q)	$h_1 > \frac{P}{dg}, h_2 > 0$	(2)	If C_1 is opened with C_2 closed, liquid will rise in the left arm but tube will not be fully filled.
(R)	$h_1 <, h_2 > 0$	(3)	If C_1 is opened with C_2 closed, tube will be fully filled with liquid.
(S)	$h_1 + h_2 <, h_2 > 0$	(4)	If C_1 is opened first and then C_2 is opened, liquid will flow down continuously.
		(5)	After any of the above action pressure at the mid -point of tube AB is non-zero

	P	Q	R	S
(A)	3,4	2,4	1,5	2,3,4,5
(B)	1,2	1,2	1,3,4,5	1,3,4,5
(C)	3,4,5	3,4	2,4	1,3,5
(D)	4,5	1,2,3	3,4,5	2,3,4,5

PFM175

59. The spring balance A reads 2 kg with a block m suspended from it. A balance B reads 5 kg when a beaker with liquid is put on the pan of the balance. The two balances are now so arranged that the hanging mass is inside the liquid in the beaker as shown in the figure in this situation:



(A) the balance A will read more than 2 kg

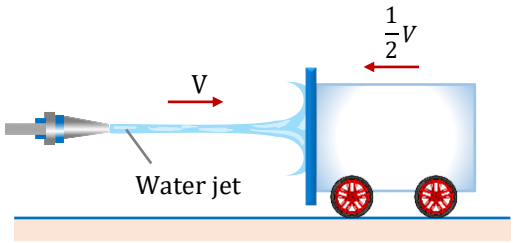
(B) the balance B will read more than 5 kg

(C) the balance A will read less than 2 kg and B will read less than 5 kg

(D) the balances A and B will read 2 kg and 5 kg respectively

PFM120

60. A horizontal water jet of constant velocity V impinges normally on a vertical flat plate and splashes off the sides in the vertical plane. The plate is moving toward the oncoming water jet with velocity $\frac{1}{2}V$. If a force F is required to maintain the plate stationary, how much force is required to move the plate toward the water jet?



(A) F (B) 1.25 F (C) 2 F (D) 2.25 F

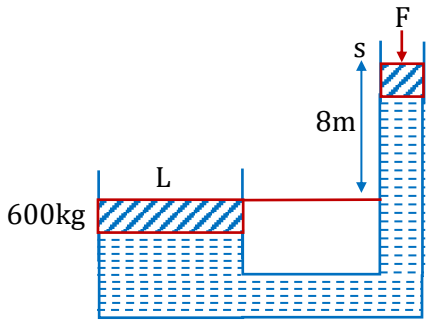
PFM135

EXERCISE - S

Pressure and Pascal's law

1. For the system shown in the figure, the cylinder on the left at L has a mass of 600 kg and a cross sectional area of 800 cm^2. The piston on the right, at S, has cross sectional area 25 cm^2 and negligible weight. If the apparatus is filled with oil. ($\rho = 0.75\ gm/cm^3$)

Find the force F required to hold the system in equilibrium.

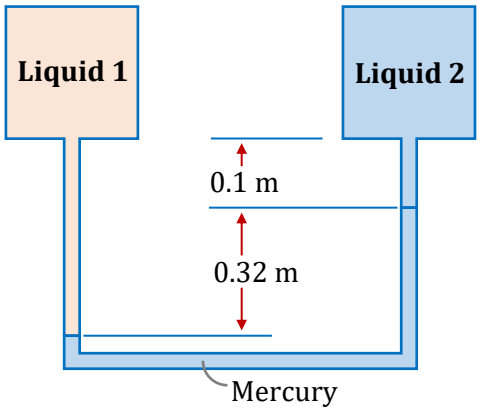


PFM088

2. The volume of an air bubble is doubled as it rises from the bottom of a lake to its surface. If the atmospheric pressure is H m of mercury and the density of mercury is n times that of lake water. Find the depth of the lake.

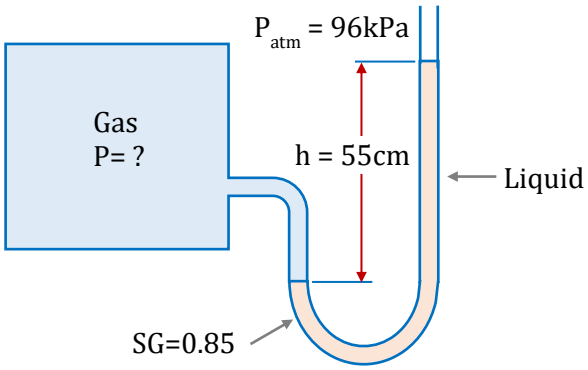
PFM089

3. A liquid filled in two vessels which are connected by narrow tube as shown in figure. If the mercury level difference between the two hands is 32 cm. Then find pressure difference between the vessels. The density of liquid and mercury is 720 kg/m^3 and 13600 kg/m^3 respectively (g = 9.8).



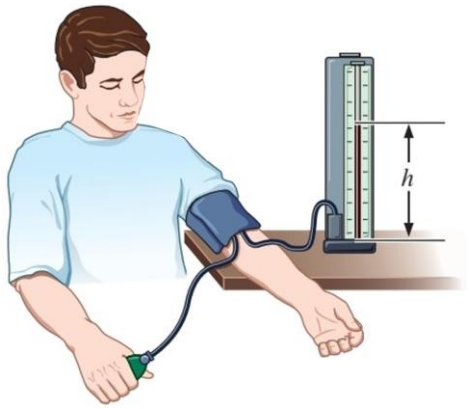
PFM091

4. In given diagram find atmospheric pressure of gas if atmospheric pressure is 96 *kPa* and relative density of liquid 0.85.



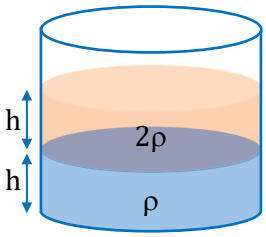
PFM092

5. The maximum blood pressure in the upper arm of a is about 120 *mmHg* which have vertical tube open to atmosphere and connected vein of the person arm and the density of blood is 1050 kg/m^3. Find how high the blood will rise in the tube.



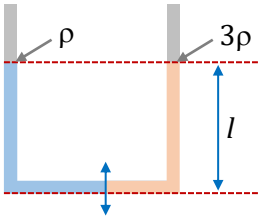
PFM093

6. As shown, a container is filled with two incompressible liquids with densities ρ and 2ρ. Find the heart at the bottom of the beaker.



PFM094

7. As shown, the U-shaped tube was filled to height *l* with two different immiscible liquids of density ρ and 3ρ separated by a valve. If the valve is open, find the new height of the liquid in both columns.

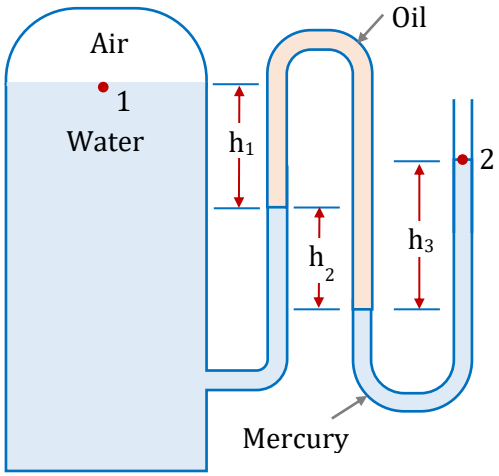


PFM095

8. The water pressure is 40,000 Pa on the ground and 10,000 Pa on first floor. Find the height of the first floor. Given the density of water at 1000 Kg/m^3, g =10 m/s^2.

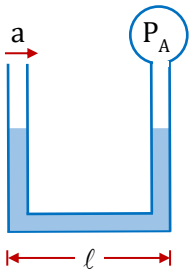
PFM096

9. The pressure exerted by air on water tank, and the pressure is measured by a multifluid manometer as shown in Fig. The tank is placed on a mountain at an altitude of 1400 m where the atmospheric pressure is 85.6 kPa. Determine the air pressure in the tank if $h_1 = 0.1m$, $h_2 = 0.2\ m$ and $h_3 = 0.35m$. Take the density of water, oil and mercury to be 1000 kg/m^3, 850 kg/m^3, and 13,600 kg/m^3, respectively.



PFM097

10. A liquid of density ρ is filled in a U-shaped tube, whose one end is open and at the other end a bulb is fitted whose pressure is P_A. Now this tube is moved horizontally with acceleration 'a' as shown in the figure. During the exercise, it was observed that the fluids in the two lines were in the same balance. If the atmospheric pressure is P_0, find the value of P_A.

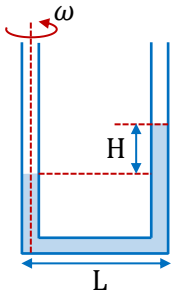


PFM098

11. A spherical tank of 1.2 m radius is half filled with oil of relative density 0.8. If the tank is given a horizontal acceleration of $10m/s^2$. Calculate the inclination of the oil surface to horizontal and maximum pressure on the tank.

PFM103

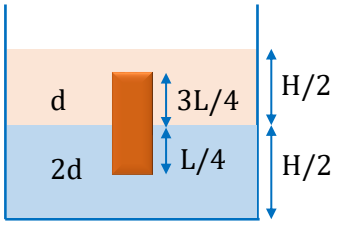
12. A U tube is rotated about one of it's limbs with an angular velocity ω. Find the difference in height H of the liquid (density r) level, where diameter of the tube $d << L$.



PFM105

Buoyancy

13. A container of a large uniform cross-sectional area A resting on a horizontal surface holds two immiscible, non-viscous and incompressible liquids of densities d and $2d$ each of height $\frac{H}{2}$ as shown. The lower density liquid is open to atmosphere. A homogeneous solid cylinder of length $L\left(<\frac{H}{2}\right)$, cross-sectional area $\frac{A}{5}$ is immersed such that it floats with its axis vertical to the liquid -liquid interface with length $\frac{L}{4}$ in denser liquid. Find the density of the solid cylinder.



PFM111

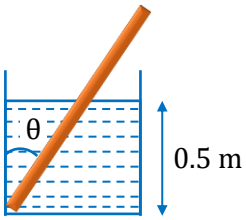
14. In air an object weighs $15N$, when immersed completely in water the same object weighs $12N$. When immersed in another liquid completely, it weighs $13N$. Find:

(a) the specific gravity of the object and

(b) the specific gravity of the other liquid.

PFM112

15. A wooden plank of length 1 m and uniform cross-section is hinged at one end to the bottom of a tank as shown. The tank is filled with water upto a height of 0.5 m. The specific gravity of the plank is 0.5. Find the angle θ made by the plank in equilibrium position



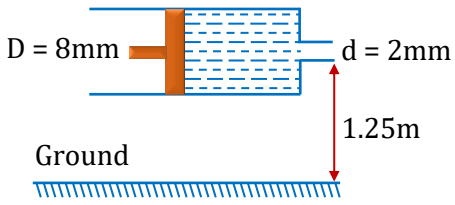
PFM113

16. A cylindrical wooden float whose base area is 4 m^2 and height 1 m drifts on the water surface in vertical position. Density of wood is 500 kg/m^3 and that of water is 1000 kg/m^3. What minimum work (in kJ) must be performed to take the float out of the water?

PFM118

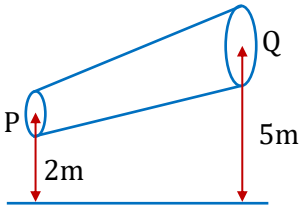
Fluid dynamics

17. 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 (in m) of water stream on the ground. Take g = 10 m/s^2.



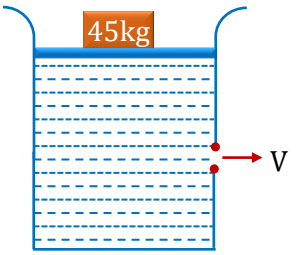
PFM125

18. A non-viscous liquid of constant density 1000 kg/m^3 flows in a streamline motion along a tube of variable cross section. The tube is kept inclined in the vertical plane as shown in the figure. The area of cross section of the tube at two points P and Q at heights of 2 meters and 5 meters are respectively $4 \times 10^{-3} m^2$ and $8 \times 10^{-3}\ m^3$. The velocity of the liquid at point P is 1 m/s. Find the work done per unit volume by the pressure and the gravity forces as the fluid flows from point P to Q.



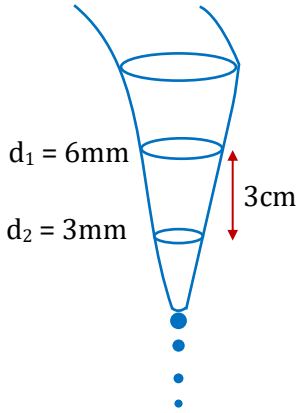
PFM126

19. A large cylindrical tank of cross-sectional area $1m^2$ is filled with water. It has a small hole at a height of $1m$ from the bottom. A movable piston of mass 5 kg is fitted on the top of the tank such that it can slide in the tank freely. A load of 45 kg is applied on the top of water by piston, as shown in figure. Find the value of v (in m/s) when piston is $7m$ above the bottom ($g = 10\ m/s^2$)



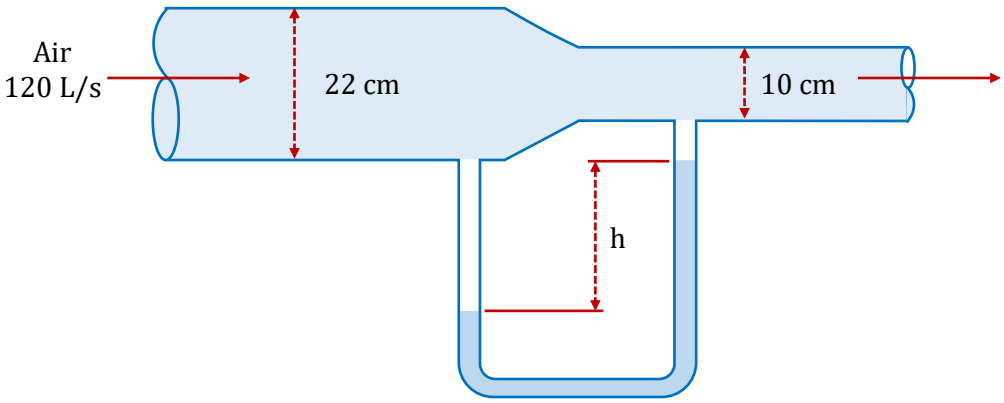
PFM130

20. The tap in the garden was closed in appropriately resulting in the water flowing freely out of it which forms a downward narrowing beam. The beam of water has a circular cross-section, the diameter of the circle is 6 mm at one point and 3 cm below it is only 3 mm as shown in figure. If the rate of water wasted is $(x \times \pi)\ mL$/minute then find the value of x.
(Neglect the effect of viscosity and surface tension of the flowing water.)



PFM133

21. Air flows through a pipe at a rate of 120 L/s. The pipe consists of two sections of diameters 22 cm and 10 cm with a smooth reducing section that connects them. The pressure difference between the two pipe sections is measured by a water manometer. Neglecting frictional effects, determine the differential height (in cm) of water between the two pipe sections. Take the air density to be 1.20 kg/m^3.



PFM134

22. A large open top container of negligible mass and uniform cross–sectional area A has a small hole of cross–sectional area $A/100$ in its side wall near the bottom. The container is kept on a smooth horizontal floor and contains a liquid of density ρ and mass m_0. Assuming that the liquid starts flowing out horizontal through the hole at $t = 0$, calculate:

(i) the acceleration of the container and

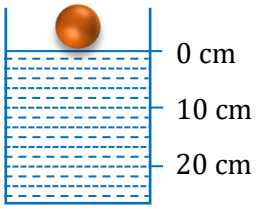
(ii) its velocity when 75% of the liquid has drained out.

PFM137

Viscosity

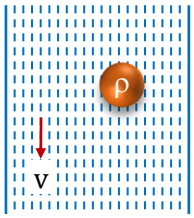
23. A spherical ball of density ρ and radius 0.003m is dropped into a tube containing a viscous fluid filled up to the 0 cm mark as shown in the figure. Viscosity of the fluid = 1.260 $Ns.m^{-2}$ and its density $\rho_L = \frac{\rho}{2} = 1260\ kg.m^{-3}$. Assume the ball reaches a terminal speed by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

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



PFM142

24. A liquid of density $\rho = 1000\ kg/m^3$ and coefficient of viscosity $h = 0.1\ Ns/m^2$ is flowing down in vertical pipe of large cross section. A small ball of density $\rho_0 = 100\ kg/m^3$ and $r = 5\ cm$ will be at rest in flowing liquid, if velocity of flowing liquid is 10 $k\ m/s$. Then find the value of k.



PFM143

25. 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.

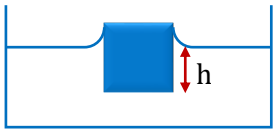
PFM144

Surface Tension

26. Two arms of a *U*-tube have unequal diameters $d_1 = 1.0\ mm$ and $d_2 = 1.0\ cm$. If water (surface tension $7 \times 10^{-2}\ N/m$) is poured into the tube held in the vertical position, find the difference of level of water in the *U*-tube. Assume the angle of contact to be zero.

PFM166

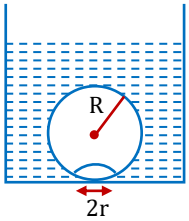
27. A cube with a mass '*m*' completely wettable by water floats on the surface of water. Each side of the cube is '*a*'. What is the distance *h* between the lower face of cube and the surface of the water if surface tension is '*s*'. Take density of water as ρ_w. Take angle of contact as zero.



PFM167

EXERCISE - JEE (Main) PYQ

1. On heating water, bubbles being formed at the bottom of the vessel detach and rise. Take the bubbles to be spheres of radius R and making a circular contact of radius r with the bottom of the vessel. If $r << R$, and the surface tension of water is T, value of r just before bubbles detach is (density of water is ρ_w)



[JEE (Main) 2014]

(1) $R^2\sqrt{\frac{\rho_w g}{T}}$ (2) $R^2\sqrt{\frac{3\rho_w g}{T}}$

(3) $R^2\sqrt{\frac{2\rho_w g}{3T}}$ (4) $R^2\sqrt{\frac{\rho_w g}{6T}}$

PFM031

2. If two glass plates have water between them and are separated by very small distance (see figure), it is very difficult to pull them apart. It is because the water in between forms cylindrical surface on the side that give rise to lower pressure in the water in comparison to the atmosphere. If the radius of the cylindrical surface is R and surface tension of water is T then the pressure in water between the plates is lower by : **[JEE (Main) 2015]**

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

PFM032

3. A thin uniform tube is bent into a circle of radius r in the vertical plane. Equal volumes of two immiscible liquids, whose densities are ρ_1 and $\rho_2(\rho_1 > \rho_2)$, fill half the circle. The angle θ between the radius vector passing through the common interface and the vertical is: **[JEE (Main) 2018]**

(1) $\theta = \tan^{-1}\pi\left(\frac{\rho_1}{\rho_2}\right)$ (2) $\theta = \tan^{-1}\frac{\pi}{2}\left(\frac{\rho_1}{\rho_2}\right)$

(3) $\theta = \tan^{-1}\left[\frac{\pi}{2}\left(\frac{\rho_1-\rho_2}{\rho_1+\rho_2}\right)\right]$ (4) None of these

PFM033

4. A cylindrical plastic bottle of negligible mass is filled with 310 *ml* of water and left floating in a pond with still water. If pressed downward slightly and released, it starts performing simple harmonic motion at angular frequency ω. If the radius of the bottle is 2.5 *cm* then ω close to :
(Density of water = 10^3 *kg / m*^{3}) **[JEE (Main) 2019]**

(1) $2.5\sqrt{10}$ *rad s*$^{-1}$ (2) 1.25 *rad s*$^{-1}$ (3) 3.75 *rad s*$^{-1}$ (4) 2.50 *rad s*$^{-1}$

PFM034

5. If '*M*' is the mass of water that rises in a capillary tube of radius '*r*', then mass of water which will rise in a capillary tube of radius '2*r*' is : **[JEE (Main) 2019]**

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

PFM035

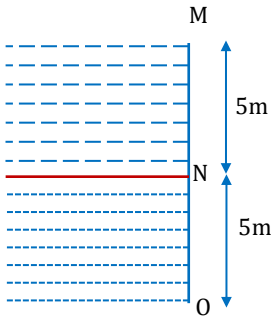
6. An ideal fluid flows (laminar flow) through a pipe of non-uniform diameter. The maximum and minimum diameters of the pipes are 6.4 *cm* and 4.8 *cm*, respectively. The ratio of the minimum and the maximum velocities of fluid in this pipe is: **[JEE (Main) 2020]**

(1) $\frac{\sqrt{3}}{2}$ (2) $\frac{3}{4}$ (3) $\frac{81}{256}$ (4) $\frac{9}{16}$

PFM036

7. Two liquids of densities ρ_1 an ρ_2 ($\rho_2 = 2\rho_1$) are filled up behind a square wall of side 10 *m* as shown in figure. Each liquid has a height of 5 *m*. The ratio of the forces due to these liquids exerted on upper part *MN* to that at the lower part *NO* is (Assume that the liquids are not mixing)

[JEE (Main) 2020]



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

PFM037

8. Two narrow bores of diameter 5.0 *mm* and 8.0 *mm* are joined together to form a *U*-shaped tube open at both ends. If this *U*-tube contains water, what is the difference in the level of two limbs of the tube.

[Take surface tension of water $T = 7.3 \times 10^{-2}\ Nm^{-1}$, angle of contact = 0, $g = 10\ ms^{-2}$ and density of water = $1.0 \times 10^3\ kg\ m^{-3}$]

[JEE (Main) 2020]

(1) 3.62 *mm* (2) 2.19 *mm* (3) 5.34 *mm* (4) 4.97 *mm*

PFM038

9. A soap bubble of radius 3 *cm* is formed inside the another soap bubble of radius 6 *cm*. The radius of an equivalent soap bubble which has the same excess pressure as inside the smaller bubble with respect to the atmospheric pressure is ..... *cm*.

[JEE (Main) 2021]

PFM039

10. In Millikan's oil drop experiment, what is viscous force acting on an uncharged drop of radius $2.0 \times 10^{-5}\ m$ and density $1.2 \times 10^3\ kgm^{-3}$? Take viscosity of liquid = $1.8 \times 10^{-5}\ Nsm^{-2}$.

(Neglect buoyancy due to air)

[JEE (Main) 2021]

(1) $3.8 \times 10^{-11}\ N$ (2) $3.9 \times 10^{-10}\ N$ (3) $1.8 \times 10^{-10}\ N$ (4) $5.8 \times 10^{-10}\ N$

PFM040

11. Suppose you have taken a dilute solution of oleic acid in such a way that its concentration becomes 0.01 cm^3 of oleic acid per cm^3 of the solution. Then you make a thin film of this solution (monomolecular thickness) of area 4 cm^2 by considering 100 spherical drops of radius $\left(\frac{3}{40\pi}\right)^{\frac{1}{3}} \times 10^{-3}\ cm$. Then the thickness of oleic acid layer will be $x \times 10^{-14}\ m$. Where *x* is_____.

[JEE (Main) 2021]

PFM041

12. A large number of water drops, each of radius *r*, combine to have a drop of radius *R*. If the surface tension is *T* and mechanical equivalent of heat is *J*, the rise in heat energy per unit volume will be:

[JEE (Main) 2021]

(1) $\frac{2T}{J}\left(\frac{1}{r}-\frac{1}{R}\right)$ (2) $\frac{2T}{rJ}$ (3) $\frac{3T}{rJ}$ (4) $\frac{3T}{J}\left(\frac{1}{r}-\frac{1}{R}\right)$

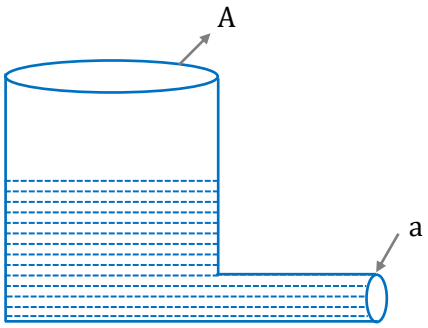
PFM042

13. Two spherical soap bubbles of radii r_1 and r_2 in vacuum combine under isothermal conditions. The resulting bubble has a radius equal to : **[JEE (Main) 2021]**

(1) $\frac{r_1 r_2}{r_1+r_2}$ (2) $\sqrt{r_1 r_2}$ (3) $\sqrt{r_1^2+r_2^2}$ (4) $\frac{r_1+r_2}{2}$

PFM043

14. A light cylindrical vessel is kept on a horizontal surface. Area of base is A. A hole of cross-sectional area 'a' is made just at its bottom side. The minimum coefficient of friction necessary to prevent sliding the vessel due to the impact force of the emerging liquid is ($a << A$) : **[JEE (Main) 2021]**



(1) $\frac{A}{2a}$ (2) None of these (3) $\frac{2a}{A}$ (4) $\frac{a}{A}$

PFM044

15. The velocity of upper layer of water in a river is 36 kmh^{-1}. Shearing stress between horizontal layers of water is 10^{-3} Nm^{-2}. Depth of the river is _m.
(Co-efficiency of viscosity of water is 10^{-2} $Pa.s$) **[JEE (Main) 2022]**

PFM045

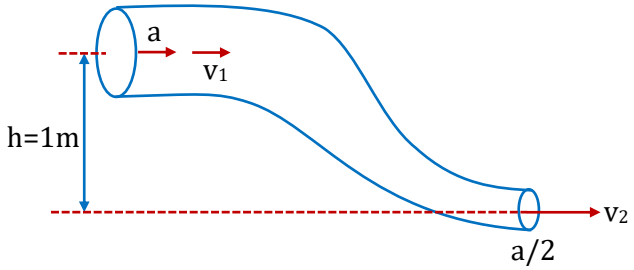
16. When a ball is dropped into a lake from a height 4.9 m above the water level, it hits the water with a velocity v and then sinks to the bottom with the constant velocity v. It reaches the bottom of the lake 4.0 s after it is dropped. The approximate depth of the lake is : **[JEE (Main) 2022]**

(A) 19.6 m (B) 29.4 m (C) 39.2 m (D) 73.5 m

PFM046

17. An ideal fluid of density 800 kgm^{-3}, flows smoothly through a bent pipe (as shown in figure) that tapers in cross-sectional area from a to $\frac{a}{2}$. The pressure difference between the wide and narrow sections of pipe is 4100 Pa. At wider section, the velocity of fluid is $\frac{\sqrt{x}}{6}$ ms^{-1} for x = ...

(Given g = 10 m^{-2})



[JEE (Main) 2022]

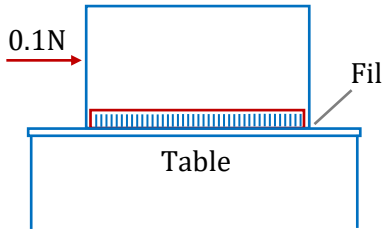
PFM047

18. A fully loaded boeing aircraft has a mass of 5.4×10^5 kg. Its total wing area is 500 m^2. It is in level flight with a speed of 1080 km/h. If the density of air ρ is 1.2 kg m^{-3} , the fractional increase in the speed of the air on the upper surface of the wing relative to the lower surface in percentage will be ($g = 10$ m/s^2)– **[JEE (Main) 2023]**

(1) 16 (2) 6 (3) 8 (4) 10

PFM048

19. A metal block of base area 0.20 m^2 is placed on a table, as shown in figure. A liquid film of thickness 0.25 mm is inserted between the block and the table. The block is pushed by a horizontal force of 0.1 N and moves with a constant speed. If the viscosity of the liquid is 5.0×10^{-3} Pl, the speed of block is _____$\times 10^{-3}$ m/s. **[JEE (Main) 2023]**



PFM049

20. The height of liquid column raised in a capillary tube of certain radius when dipped in liquid A vertically is, 5 cm. If the tube is dipped in a similar manner in another liquid B of surface tension and density double the values of liquid A, the height of liquid column raised in liquid B would be ____ m. **[JEE (Main) 2023]**

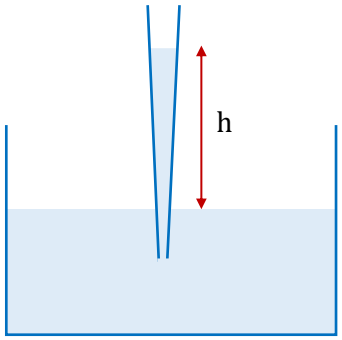
(1) 0.20 (2) 0.5 (3) 0.05 (4) 0.10

PFM050

EXERCISE - JEE (Advanced) PYQ

1. A glass capillary tube is of the shape of truncated cone with an apex angle α so that its two ends have cross sections of different radii. When dipped in water vertically, water rises in it to height h, where the radius of its cross section is b. If the surface tension of water is S, its density is ρ, and its contact angle with glass is θ, the value of h will be (g is the acceleration due to gravity)

[JEE (Advanced) 2014]



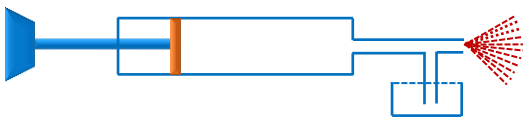
(A) $\frac{2S}{b\rho g}\cos(\theta - \alpha)$ (B) $\frac{2S}{b\rho g}\cos(\theta + \alpha)$

(C) $\frac{2S}{b\rho g}\cos(\theta - \alpha/2)$ (D) $\frac{2S}{b\rho g}\cos(\theta + \alpha/2)$

PFM069

PARAGRAPH FOR Q.NO. 2 AND 3

A spray gun is shown in the figure where a piston pushes air out of a nozzle. A thin tube of uniform cross section is connected to the nozzle. The other end of the tube is in a small liquid container. As the piston pushes air through the nozzle, the liquid from the container rises into the nozzle and is sprayed out. For the spray gun shown, the radii of the piston and the nozzle are 20 *mm* and 1 *mm* respectively. The upper end of the container is open to the atmosphere. **[JEE (Advanced) 2014]**



2. If the piston is pushed at a speed of 5 mms^{-1}, the air comes out of the nozzle with a speed of

(A) 0.1 ms^{-1} (B) 1 ms^{-1} (C) 2 ms^{-1} (D) 8 ms^{-1}

PFM070

3. If the density of air is ρ_a and that of the liquid ρ_ℓ, then for a given piston speed the rate (volume per unit time) at which the liquid is sprayed will be proportional to

(A) $\sqrt{\frac{\rho_a}{\rho_\ell}}$ (B) $\sqrt{\rho_a \rho_\ell}$ (C) $\sqrt{\frac{\rho_\ell}{\rho_a}}$ (D) ρ_ℓ

PFM071

4. A person in a lift is holding a water jar, which has a small hole at the lower end of its side. When the lift is at rest, the water jet coming out of the hole hits the floor of the lift at a distance d of 1.2 m from the person. In the following, state of the lift's motion is given in List I and the distance where the water jet hits the floor of the lift is given in List II. Match the statements from List I with those in List II and select the correct answer using the code given below the lists. **[JEE (Advanced) 2014]**

List - I		**List-II**	
(P)	Lift is accelerating vertically up.	(1)	$d = 1.2\ m$
(Q)	Lift is accelerating vertically down with an acceleration less than the gravitational acceleration.	(2)	$d > 1.2\ m$
		(3)	$d < 1.2\ m$
		(4)	No water leaks out of the jar
(R)	Lift is moving vertically up with constant speed.		
(S)	Lift is falling freely.		

Code:

(A) P-2, Q-3, R-2, S-4 (B) P-2, Q-3, R-1, S-4

(C) P-1, Q-1, R-1, S-4 (D) P-2, Q-3, R-1, S-1

PFM072

5. Consider two solid spheres P and Q each of density 8 $gm\ cm^{-3}$ and diameters 1 cm and 0.5 cm, respectively. Sphere P is dropped into a liquid of density 0.8 $gm\ cm^{-3}$ and viscosity $\eta = 3$ poiseulles. Sphere Q is dropped into a liquid of density 1.6 $gm\ cm^{-3}$ and viscosity $\eta = 2$ poiseulles. The ratio of the terminal velocities of P and Q is. **[JEE (Advanced) 2016]**

PFM073

6. A drop of liquid of radius $R = 10^{-2}\ m$ having surface tension $S = \frac{0.1}{4\pi} Nm^{-1}$ divides itself into K identical drops. In this process the total change in the surface energy $\Delta U = 10^{-3}\ J$. If $K = 10^{\alpha}$ then the value of α is **[JEE (Advanced) 2017]**

PFM074

7. Consider a thin square plate floating on a viscous liquid in a large tank. The height h of the liquid in the tank is much less than the width of the tank. The floating plate is pulled horizontally with a constant velocity u_0. Which of the following statements is (are) true ? **[JEE (Advanced) 2018]**

(A) The resistive force of liquid on the plate is inversely proportional to h

(B) The resistive force of liquid on the plate is independent of the area of the plate

(C) The tangential (shear) stress on the floor of the tank increases with u_0.

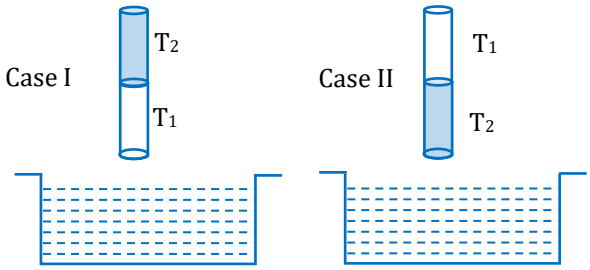
(D) The tangential (shear) stress on the plate varies linearly with the viscosity h of the liquid.

PFM075

8. A cylindrical capillary tube of 0.2 *mm* radius is made by joining two capillaries T_1 and T_2 of different materials having water contact angles of 0° and 60°, respectively. The capillary tube is dipped vertically in water in two different configurations, case I and II as shown in figure. Which of the following option(*s*) is(are) correct?

(Surface tension of water = 0.075 N/m, density of water = 1000 kg/m^3, take g = 10 m/s^2)

[JEE (Advanced) 2019]



(A) The correction in the height of water column raised in the tube, due to weight of water contained in the meniscus, will be different for both cases.

(B) For case I, if the capillary joint is 5 *cm* above the water surface, the height of water column raised in the tube will be more than 8.75 *cm*. (Neglect the weight of the water in the meniscus)

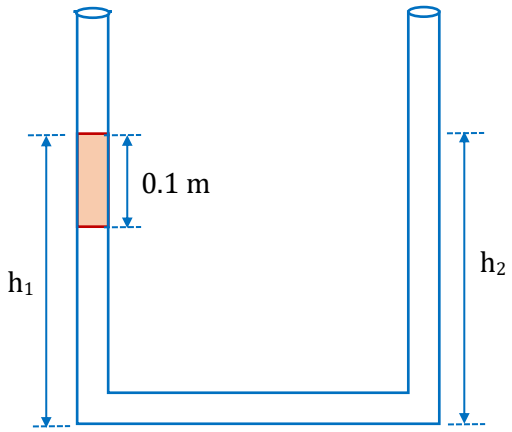
(C) For case I, if the joint is kept at 8 *cm* above the water surface, the height of water column in the tube will be 7.5 *cm*. (Neglect the weight of the water in the meniscus)

(D) For case II, if the capillary joint is 5 *cm* above the water surface, the height of water column raised in the tube will be 3.75 *cm*. (Neglect the weight of the water in the meniscus)

PFM076

9. An open-ended *U*-tube of uniform cross-sectional area contains water (density $10^3 kg\ m^{-3}$). Initially the water level stands at 0.29 *m* from the bottom in each arm. Kerosene oil (a water-immiscible liquid) of density 800 $kg\ m^{-3}$ is added to the left arm until its length is 0.1 *m*, as shown in the schematic figure below. The ratio $\left(\frac{h_1}{h_2}\right)$of the heights of the liquid in the two arms is-

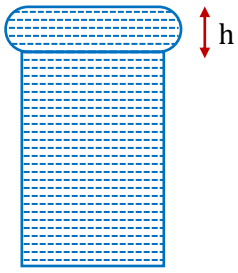
[JEE (Advanced) 2020]



(A) $\frac{15}{14}$ (B) $\frac{35}{33}$ (C) $\frac{7}{6}$ (D) $\frac{5}{4}$

PFM077

10. When water is filled carefully in a glass, one can fill it to a height h above the rim of the glass due to the surface tension of water. To calculate h just before water starts flowing, model the shape of the water above the rim as a disc of thickness h having semicircular edges, as shown schematically in the figure. When the pressure of water at the bottom of this disc exceeds what can be withstood due to the surface tension, the water surface breaks near the rim and water starts flowing from there. If the density of water, its surface tension and the acceleration due to gravity are $10^3 kg\ m^{-3}$, $0.07\ Nm^{-1}$ and $10\ ms^{-2}$, respectively, the value of h (in mm) is _____.



[JEE (Advanced) 2020]

PFM078

11. A train with cross-sectional area S_t is moving with speed v_t inside a long tunnel of cross-sectional area S_0 ($S_0 = 4S_t$). Assume that almost all the air (density ρ) in front of the train flows back between its sides and the walls of the tunnel. Also, the air flow with respect to the train is steady and laminar. Take the ambient pressure and that inside the train to be p_0. If the pressure in the region between the sides of the train and the tunnel walls is p, then $p_0 - p = \frac{7}{2N}\rho v_t^2$. The value of N is _____.

[JEE (Advanced) 2020]

PFM079

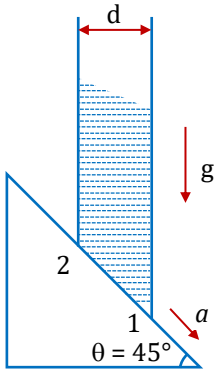
12. A hot air balloon is carrying some passengers, and a few sandbags of mass 1 kg each so that its total mass is 480 kg. Its effective volume giving the balloon its buoyancy is V. The balloon is floating at an equilibrium height of 100 m. When N number of sandbags are thrown out, the balloon rises to a new equilibrium height close to 150 m with its volume V remaining unchanged. If the variation of the density of air with height h from the ground is $\rho(h) = \rho_0 e^{-\frac{h}{h_0}}$, where $\rho_0 = 1.25\ kg\ m^{-3}$ and $h_0 = 6000\ m$, the value of N is _____. **[JEE (Advanced) 2020]**

PFM080

13. A cubical solid aluminium (bulk modulus $= -V\frac{dP}{dV} = 70\ GPa$) block has an edge length of 1 m on the surface of the earth. It is kept on the floor of a 5 km deep ocean. Taking the average density of water and the acceleration due to gravity to be $10^3\ kg\ m^{-3}$ and $10\ ms^{-2}$, respectively, the change in the edge length of the block in mm is ____. **[JEE (Advanced) 2020]**

PFM081

14. A cylindrical tube, with its base as shown in the figure, is filled with water. It is moving down with a constant acceleration a along a fixed inclined plane with angle $\theta = 45°$. P_1 and P_2 are pressures at points 1 and 2, respectively, located at the base of the tube. Let $\beta = (P_1 - P_2)/(\rho g d)$, where ρ is density of water, d is the inner diameter of the tube and g is the acceleration due to gravity. Which of the following statement(s) is(are) correct? **[JEE (Advanced) 2021]**



(A) $\beta = 0$ when $a = g/\sqrt{2}$

(B) $\beta > 0$ when $a = g/\sqrt{2}$

(C) $\beta = \frac{\sqrt{2}-1}{\sqrt{2}}$ when $a = g/2$

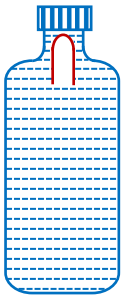
(D) $\beta = \frac{1}{\sqrt{2}}$ when $a = g/2$

PFM082

QUESTION STEM FOR QUESTION NO. 15 AND 16

A soft plastic bottle, filled with water of density 1 gm/cc, carries an inverted glass test-tube with some air (ideal gas) trapped as shown in the figure. The test-tube has a mass of 5 gm, and it is made of a thick glass of density 2.5 gm/cc. Initially the bottle is sealed at atmospheric pressure $p_0 = 10^5\ Pa$ so that the volume of the trapped air is $v_0 = 3.3\ cc$. When the bottle is squeezed from outside at constant temperature, the pressure inside rises and the volume of the trapped air reduces. It is found that the test tube begins to sink at pressure $p_0 + \Delta p$ without changing its orientation. At this pressure, the volume of the trapped air is $v_0 - \Delta v$.

Let $\Delta v = X\ cc$ and $\Delta p = Y \times 10^3\ Pa$. **[JEE (Advanced) 2021]**



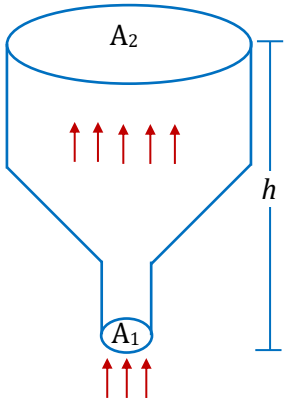
15. The value of X is ___.

PFM083

16. The value of Y is ___.

PFM084

17. An ideal gas of density $\rho = 0.2\ kg\ m^{-3}$ enters a chimney of height h at the rate of $\alpha = 0.8 kgs^{-1}$ from its lower end, and escapes through the upper end as shown in the figure. The cross-sectional area of the lower end is $A_1 = 0.1\ m^2$ and the upper end is $A_2 = 0.4\ m^2$. The pressure and the temperature of the gas at the lower end are 600 *Pa* and 300 *K*, respectively, while its temperature at the upper end is 150 *K*. The chimney is heat insulated so that the gas undergoes adiabatic expansion. Take $g = 10\ ms^{-2}$ and the ratio of specific heats of the gas $\gamma = 2$. Ignore atmospheric pressure.



Which of the following statement(s) is(are) correct? **[JEE (Advanced) 2022]**

(A) The pressure of the gas at the upper end of the chimney is 300 *Pa*.

(B) The velocity of the gas at the lower end of the chimney is 40 ms^{-1} and at the upper end is 20 ms^{-1}.

(C) The height of the chimney is 590 *m*.

(D) The density of the gas at the upper end is 0.05 $kg\ m^{-3}$.

PFM085

18. A bubble has surface tension *S*. The ideal gas inside the bubble has ratio of specific heats $\gamma = \frac{5}{3}$. The bubble is exposed to the atmosphere, and it always retains its spherical shape. When the atmospheric pressure is P_{a1}, the radius of the bubble is found to be r_1 and the temperature of the enclosed gas is T_1. When the atmospheric pressure is P_{a2}, the radius of the bubble and the temperature of the enclosed gas are r_2 and T_2, respectively.

Which of the following statement(s) is(are) correct? **[JEE (Advanced) 2022]**

(A) If the surface of the bubble is a perfect heat insulator, then $\left(\frac{r_1}{r_2}\right)^5 = \frac{P_{a2}+\frac{2S}{r_2}}{P_{a1}+\frac{2S}{r_1}}$.

(B) If the surface of the bubble is a perfect heat insulator, then the total internal energy of the bubble including its surface energy does not change with the external atmospheric pressure.

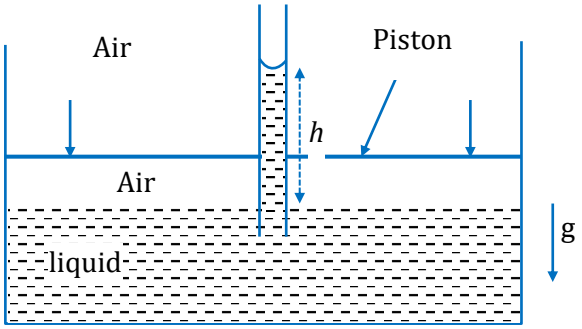
(C) If the surface of the bubble is a perfect heat conductor and the change in atmospheric temperature is negligible, then $\left(\frac{r_1}{r_2}\right)^3 = \frac{P_{a2}+\frac{4S}{r_2}}{P_{a1}+\frac{4S}{r_1}}$.

(D) If the surface of the bubble is a perfect heat insulator, then $\left(\frac{T_2}{T_1}\right)^{\frac{5}{2}} = \frac{P_{a2}+\frac{4S}{r_2}}{P_{a1}+\frac{4S}{r_1}}$.

PFM086

19. An incompressible liquid is kept in a container having a weightless piston with a hole. A capillary tube of inner radius 0.1 mm is dipped vertically into the liquid through the airtight piston hole, as shown in the figure. The air in the container is isothermally compressed from its original volume V_0 to $\frac{100}{101}V_0$ with the movable piston. Considering air as an ideal gas, the height (h) of the liquid column in the capillary above the liquid level in cm is_____.

[Given: Surface tension of the liquid is 0.075 Nm^{-1}, atmospheric pressure is 10^5 Nm^{-2}, acceleration due to gravity (g) is 10 ms^{-2}, density of the liquid is 10^3 $kg\ m^{-3}$ and contact angle of capillary surface with the liquid is zero] **[JEE (Advanced) 2023]**



PFM176

JEE (Main) Practice Paper

This paper is for yourself practice and assessment the discussion of this paper is optional though you can see PDF solutions or video solutions or solutions in hardcopy whichever is provided.

SECTION–A

- This section contains **TWENTY** questions.
- Each question has **FOUR** options (1), (2), (3) and (4). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +4, if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0, if none of the bubbles is darkened.
Negative Marks : –1 in all other cases.

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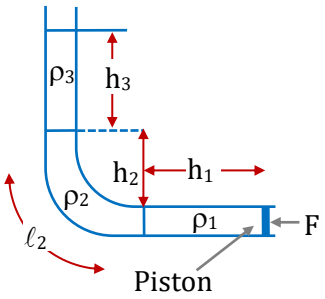
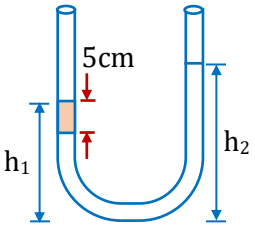
1. A tube is bent into *L* shape and kept in a vertical plane. If these three liquids are kept in equilibrium by the piston of area *A*, the value of $\frac{F}{A}$ is:



(1) $(p_1h_1 + p_2h_2 + p_3h_3)g$ (2) $(p_1h_1 + p_2f_2 + p_3h_3)g$
(3) $(p_2h_2 + p_3h_3)g$ (4) $(p_2f_2 + p_3h_3)g$

PFM001

2. An open-ended U-tube of uniform cross-sectional area contains water (density 1.0 gram/centimeter^3) standing initially 20 centimeters from the bottom in each arm. An immiscible liquid of density 4.0 grams/centimeter^3 is added to one arm until a layer 5 centimeters high forms, as shown in the figure above. What is the ratio h_2/h_1 of the heights of the liquid in the two arms?



(1) 3/1 (2) 5/2 (3) 2/1 (4) 3/2

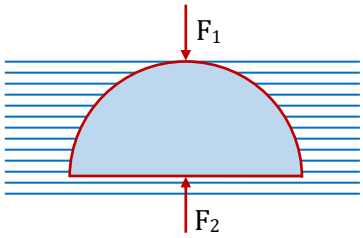
PFM002

3. A vessel filled with a liquid of density ρ falls vertically downwards with an acceleration $a(<g)$. The guage pressure *P* at depth *h* below the free surface of liquid is :

(1) $P = h\rho(g + a)$ (2) $P = h\rho g$ (3) $P = h\rho(g - a)$ (4) $P = h\rho a$

PFM003

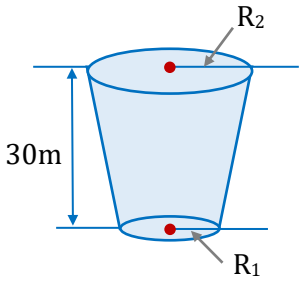
4. A solid hemisphere is just pressed below the liquid, the value of $\frac{F_1}{F_2}$ is (where F_1 and F_2 are the hydrostatic forces acting on the curved and flat surfaces of the hemisphere)
(Neglect atmospheric pressure).



(1) $\frac{1}{2}$ (2) $\frac{2}{3}$ (3) $\frac{1}{3}$ (4) None of these

PFM004

5. As the drawing illustrates, a pond full of water has the shape of an inverted cone with the tip sliced off and has a depth of $30m$. The atmospheric pressure above the pond is $1.0 \times 10^5\, Pa$. The circular top surface (radius = R_2) and circular bottom surface (radius = R_1) of the pond are both parallel to the ground. The magnitude of the force acting on the top surface by the liquid is the same as the magnitude of the force acting on the bottom surface by the liquid. Obtain $\frac{R_2}{R_1}$.



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

PFM005

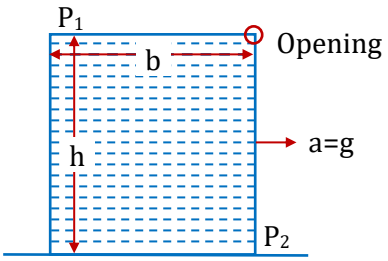
6. Two communicating vessels contain mercury. The diameter of one vessel is n times larger than the diameter of the other. A column of water of height h is poured into the left vessel. Find the level of mercury that will rise in the right hand vessel is.

(s = relative density of mercury and ρ = density of water) by

(1) $\frac{n^2 h}{(n+1)^2 s}$ (2) $\frac{h}{(n^2+1)s}$ (3) $\frac{h}{(n+1)^2 s}$ (4) $\frac{h}{n^2 s}$

PFM177

7. A closed rectangular vessel completely filled with a liquid of density ρ moves with an acceleration $a = g$. The value of the pressure difference $(P_1 - P_2)$ is :



(1) ρgb (2) $\frac{\rho g(b+h)}{2}$ (3) $\rho(gb - gh)$ (4) ρgh

PFM007

8. A cork of density 0.5 gcm^{-3} floats on a calm swimming pool. The fraction of the cork's volume which is under water is :-

(1) 0% (2) 25% (3) 10% (4) 50%

PFM008

9. A solid floats with 2/3 of its volume immersed in a liquid and with 3/4 of its volume immersed in another liquid. What fraction of its volume will be immersed if it floats in a homogenous mixture formed of equal volumes of the liquids?

(1) 6/7 (2) 8/11 (3) 11/16 (4) 12/17

PFM009

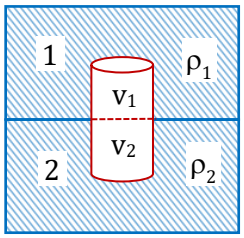
10. A small ball of relative density 0.8 falls into water from a height of $2m$. The depth to which the ball will sink is (Neglect viscous forces):

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

PFM010

11. **Statement-1 :** When a body floats such that it's parts are immersed into two immersible liquids then force exerted by liquid-1 is of magnitude $\rho_1 v_1 g$.

Statement-2 : Total Buogyant force = $\rho_1 v_1 g + \rho_2 v_2 g$



(1) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.

(2) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.

(3) Statement-1 is true, statement-2 is false.

(4) Statement-1 is false, statement-2 is true.

PFM011

12. In the case of a fluid, Bernoulli's theorem expresses the application of the principle of conservation of:-

(1) linear momentum (2) energy

(3) mass (4) angular momentum

PFM012

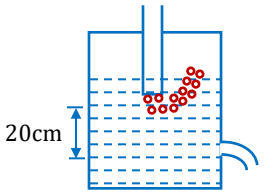
13. **Statement-1 :** Submarine sailors are advised that they should not allow it to rest on floor of the ocean.
Statement-2 : The force exerted by a liquid on a submerged body may be downwards.
(1) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.
(2) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.
(3) Statement-1 is true, statement-2 is false.
(4) Statement-1 is false, statement-2 is true.

PFM013

14. A cylinder of height 20 m is completely filled with water. The velocity of efflux of water (in ms^{-1}) through a small hole on the side wall of the cylinder near its bottom, is-
(1) 10 m/s (2) 20 m/s (3) 25.5 m/s (4) 5 m/s

PFM014

15. A tube is attached as shown in closed vessel containing water. The velocity of water coming out from a small hole is:



(1) $\sqrt{2}m/s$
(2) 2 m/s
(3) depends on pressure of air inside vessel
(4) none of these

PFM015

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 $\frac{a}{A} = 0.1$ then v^2 is (where v is the velocity of water coming out of the hole)
(1) 48 (2) 51 (3) 50 (4) 51.5

PFM016

17. Spherical balls of radius R are falling in a viscous fluid of viscosity η with a velocity v. the retarding viscous force acting on the spherical ball is-
(1) directly proportional to R but inversely proportional to v
(2) directly proportional to both radius R and velocity v
(3) inversely proportional to both radius R and velocity v
(4) inversely proportional to R but directly proportional to velocity v

PFM017

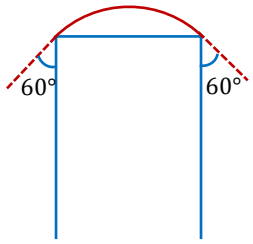
18. A laminar stream is flowing vertically down from a tap of cross-section area 1 cm^2. At a distance 10 cm below the tap, the cross-section area of the stream has reduced to 1/2 cm^2. Find the volumetric flow rate of water from the tap.
(1) 4.9 litre/min (2) 2.9 litre/min (3) 3.9 litre/min (4) 6.9 litre/min

PFM018

19. **Statement-1 :** The free surface of a liquid at rest with respect to stationary container is always normal to the eff. g.
Statement-2 : Liquids at rest cannot have shear stress.
(1) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.
(2) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1.
(3) Statement-1 is true, statement-2 is false.
(4) Statement-1 is false, statement-2 is true.

PFM019

20. A soap bubble is being blown on a tube of radius 1 cm. The surface tension of the soap solution is 0.05 N/m and the bubble makes an angle of 60° with the tube as shown. The excess of pressure over the atmospheric pressure in the tube is :



(1) 5 Pa

(2) 1 Pa

(3) 10 Pa

(4) 20 Pa

PFM020

SECTION–B

- This section will have **TEN questions**. Candidate can choose to attempt any 5 questions out of these 10 questions. In case if candidate attempts more than 5 questions, first 5 attempted questions will be considered for marking.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value (Answer should be rounded off to the nearest integer).
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4, if only correct answer is given.
Zero Marks	:	0, if no answer is given.
Negative Marks	:	–1 for incorrect answer.

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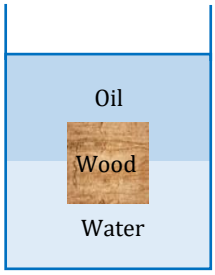
1. Dams at two different locations are needed to form a lake. When the lake is filled, the water level will be at top of both dams. The second dam is twice as high and twice as wide as the first dam. The force of the water on the second dam is how much greater than the force on the first?
(Ignore atmospheric pressure since it is pushing on both sides of the dams.)

PFM021

2. A cubical block of wood of side of 10 cm, floats at the interface between oil and water as shown in figure with its lower face 2 cm below the interface. The density of oil is 0.6 g/cm^3. The mass of the block is _____ g.



PFM022

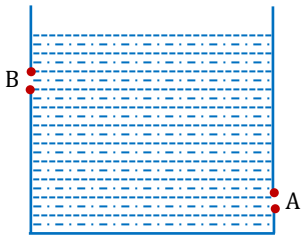
3. Two cubes of size 1.0 m sides, one of relative density 0.60 and another of relative density = 1.15 are connected by weightless wire and placed in a large tank of water. Under equilibrium the lighter cube will project above the water surface to a height _____ cm.

PFM023

4. 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. Find the force (in N) that the plate experiences.

PFM024

5. Two identical holes each of cross-sectional area $10^{-3}\ m^2$ are made on the opposite sides of a tank containing water as shown in the figure. As the water comes out of the holes, the tank will experience a net horizontal force of 20 *N*. The difference in height (in *m*) between the holes *A* and *B* is.



PFM025

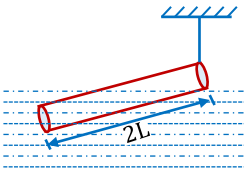
6. A cylindrical vessel open at the top is 20 *cm* high and 10 *cm* in diameter. A circular hole whose cross-sectional area 1 cm^2 is cut at the centre of the bottom of the vessel. Water flows from a tube above it into the vessel at the rate 100 cm^3s^{-1}. Find the height (in cm) of water in the vessel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

PFM026

7. Two drops of same radius are falling through air with steady velocity of *v cm/s*. If the two drops coalesce, the terminal velocity $x^{1/3}\ v$. What is the value of *x*.

PFM027

8. A slender homogeneous rod of length 2*L* floats partly immersed in water, being supported by a string fastened to one of its ends, as shown. The specific gravity of the rod is 0.75. The length of rod that extends out of water is _____*L*.

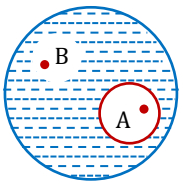


PFM028

9. A 20 *cm* long capillary tube is dipped in water. The water rises upto 8 *cm*. If the entire arrangement is put in a freely falling elevator, the length of water column in the capillary tube will be _____*cm*.

PFM029

10. There is an air bubble of radius *R* inside a drop of water of radius 3*R*. Find the ratio of gauge pressure at point *A* to the gauge pressure at point *B*.



PFM030

JEE (Advanced) Practice Paper

This paper is for yourself practice and assessment the discussion of this paper is optional though you can see PDF solutions or video solutions or solutions in hardcopy whichever is provided.

SECTION–I

- This section contains **ELEVEN** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +3 if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0 if none of the bubbles is darkened.
Negative Marks : –1 in all other cases.

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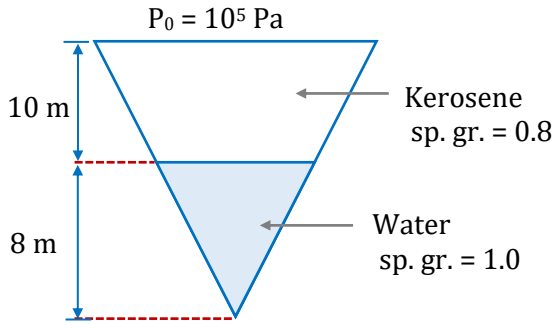
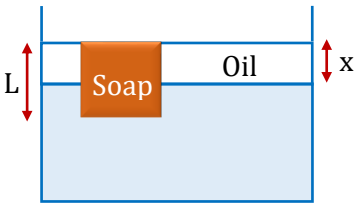
1. Shown in figure, a conical container of half-apex angle 37° filled with certain quantities of kerosene and water. The force exerted by the water on the kerosene is approximately.
(Take atmospheric pressure = 10^5 *Pa*)



(A) 3×10^7 *N* (B) 4×10^7 *N* (C) 2×10^7 *N* (D) 5×10^7 *N*

PFM051

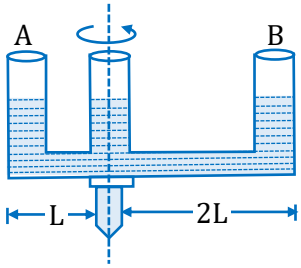
2. A rectangular bar of soap has density 800 kg/m^3 floats in water of density 1000 kg/m^3. Oil of density 300 kg/m^3 is slowly added, forming a layer that does not mix with the water. When the top surface of the oil is at the some level as the top surface of the soap. What is the ratio of the oil layer thickness to the soap's thickness, x/L ?



(A) $\frac{2}{10}$ (B) $\frac{2}{7}$ (C) $\frac{3}{10}$ (D) $\frac{3}{8}$

PFM052

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



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

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

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

(D) Water levels remains same in both sections

PFM178

4. A wooden block floats in water in a sealed container. When the container is at rest, 25% of the block is above the water. Consider the following five situation:

(i) the container is lifted up at constant speed.

(ii) the container is lowered at constant speed.

(iii) the container is lifted up at an increasing speed.

(iv) the container is lowered at a decreasing speed.

(v) the air pressure above the water in the container is increased.

What happens in each situation?

(A) 75% of block is submerged in situation (i) and (ii) and higher fraction is submerged in situations (iii), (iv) and (v).

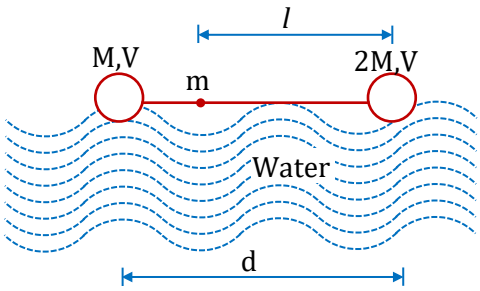
(B) 75% of block is submerged in situation (i), (ii) and (v) and higher fraction is submerged in situations (iii), (iv).

(C) 75% of block is submerged in situation (i), (ii), (iii) and (iv) and higher fraction is submerged in situations (v).

(D) 75% of block is submerged in all situation.

PFM054

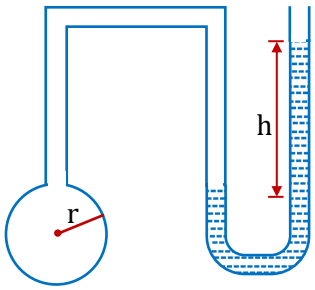
5. A dumbbell is placed in water of density ρ. It is observed that by attaching a mass *m* to the rod, the dumbbell floats with the rod horizontal on the surface of water and each sphere exactly half submerged as shown in the figure. The volume of the mass *m* is negligible. The value of length *l* is:-



(A) $\frac{d(V\rho-3M)}{2(V\rho-2M)}$ (B) $\frac{d(V\rho-2M)}{2(V\rho-3M)}$ (C) $\frac{d(V\rho+2M)}{2(V\rho-3M)}$ (D) $\frac{d(V\rho-2M)}{2(V\rho+3M)}$

PFM055

6. If the radius of the Soap-bubble on one side of tube is *r* and difference in height of liquid of density ρ in manometer is *h*, then surface tension of liquid used to make the bubble is :-



(A) $T = 2r\rho hg$ (B) $T = \frac{rh\rho g}{4}$ (C) $T = \frac{2\pi rh\rho g}{2}$ (D) $T = \frac{rh\rho g}{2}$

PFM056

7. Water coming out of a horizontal tube at a speed v strikes normally a vertically wall close to the mouth of the tube and falls down vertically after impact. When the speed of water is increased to 2v.

(A) The thrust exerted by the water on the wall will be doubled.

(B) The thrust exerted by the water on the wall will be unchanged.

(C) The energy lost per second by water striking the wall will also be four times.

(D) The energy lost per second by water striking the wall be increased eight times.

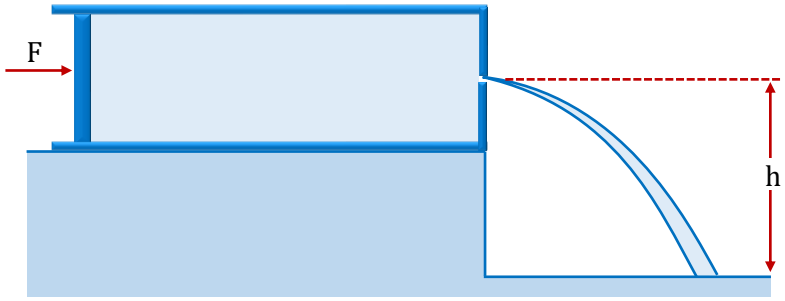
PFM057

8. Fountains usually seen in gardens are generated by a wide pipe with an enclosure at one end having many small holes. Consider one such fountain which is produced by a pipe of internal diameter 2 *cm* in which water flows at a rate 3 ms^{-1}. The enclosure has 100 holes each of diameter 0.05 *cm*. The velocity of water coming out of the holes is (in ms^{-1}):

(A) 0.48 (B) 96 (C) 24 (D) 48

PFM058

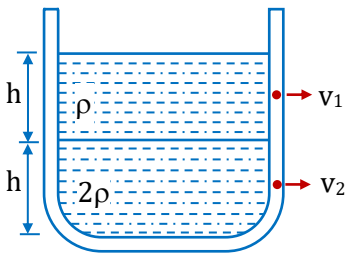
9. An ideal liquid of density ρ is filled in a horizontally fixed syringe fitted with piston. There is no friction between the piston and the inner surface of the syringe. Cross-section area of the syringe is *A*. At one end of the syringe, an orifice of negligible cross-section area is made. When the piston is pushed into the syringe, the liquid comes out of the orifice following parabolic path and falls on the ground. With what speed the liquid strikes the ground? Neglect the air drag :-



(A) $\sqrt{\frac{F+\rho ghA}{\rho A}}$ (B) $\sqrt{\frac{F+2\rho ghA}{\rho A}}$ (C) $\sqrt{\frac{2F+\rho ghA}{\rho A}}$ (D) $\sqrt{\frac{2(F+\rho ghA)}{\rho A}}$

PFM059

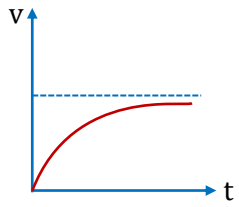
10. Equal volumes of two immiscible liquids of densities ρ and 2ρ are filled in a vessel as shown in figure. Two small holes are punched at depth $h/2$ and 3 $h/2$ from the surface of lighter liquid. If v_1 and v_2 are the velocities of a flux at these two holes, then v_1/v_2 is :

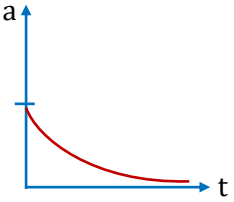


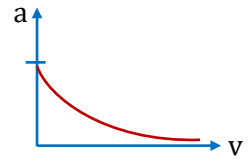
(A) $\frac{1}{2\sqrt{2}}$ (B) $\frac{1}{2}$ (C) $\frac{1}{4}$ (D) $\frac{1}{\sqrt{2}}$

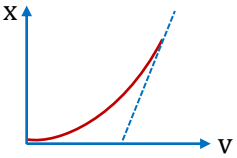
PFM060

11. Which of the following is the ***incorrect*** graph for a sphere falling in a viscous liquid?
(Given at $t = 0$, velocity $v = 0$ and displacement $x = 0$.)

(A) 

(B) 

(C) 

(D) 

PFM061

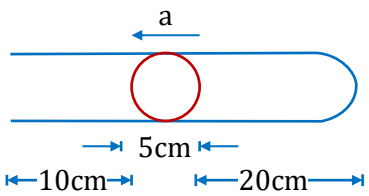
SECTION-II

- This section contains **THREE** questions.
- Each question has **FOUR** options for correct answer(*s*). **ONE OR MORE THAN ONE** of these four option(*s*) is (are) correct option(*s*).
- For each question, choose the correct option(*s*) to answer the question.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks	: +4	if only (all) the correct option(*s*) is (are) chosen.
Partial Marks	: +3	if all the four options are correct but ONLY three options are chosen.
Partial Marks	: +2	if three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks	: +1	if two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks	: 0	if none of the options is chosen (i.e. the question is unanswered).
Negative Marks	: –2	in all other cases.

For Example : If first, third and fourth are the **ONLY** three correct options for a question with second option being an incorrect option; selecting only all the three correct options will result in +4 marks. Selecting only two of the three correct options (e.g. the first and fourth options), without selecting any incorrect option (second option in this case), will result in +2 marks. Selecting only one of the three correct options (either first or third or fourth option), without selecting any incorrect option (second option in this case), will result in +1 marks. Selecting any incorrect option(*s*) (second option in this case), with or without selection of any correct option(*s*) will result in –2 marks.

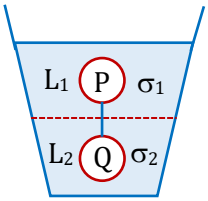
12. A mercury pallet of length 5 *cm* is trapped in a horizontal tube of small cross–section area. Length of tube enclosed by mercury pallet is 20 *cm* when it is accelerated with $a = g/2$ in the direction shown. The length of tube enclosed by pallet if it is accelerated in opposite direction with same acceleration is : (Atmospheric pressure is 72.5 *cm* of *Hg*)



(A) 22 *cm* (B) 22.5 *cm* (C) 21 *cm* (D) 21.4 *cm*

PFM179

13. Two spheres *P* and *Q* of equal radii have densities ρ_1 and ρ_2, respectively. The spheres are connected by a massless string and placed in liquids L_1 and L_2 of densities σ_1 and σ_2 and viscosities η_1 and η_2, respectively. They float in equilibrium with the sphere *P* in L_1 and sphere *Q* in L_2 and the string being taut (see figure). If sphere *P* alone in L_2 has terminal velocity $\vec{V}_P$ and *Q* alone in L_1 has terminal velocity $\vec{V}_Q$, then



(A) $\frac{|\vec{V}_P|}{|\vec{V}_Q|} = \frac{\eta_1}{\eta_2}$ (B) $\frac{|\vec{V}_P|}{|\vec{V}_Q|} = \frac{\eta_2}{\eta_1}$ (C) $\vec{V}_P.\vec{V}_Q > 0$ (D) $\vec{V}_P.\vec{V}_Q < 0$

PFM063

14. A uniform capillary tube of inner radius *r* is dipped vertically into a beaker filled with water. The water rises to a height *h* in the capillary tube above the water surface in the beaker. The surface tension of water is σ. The angle of contact between water and the wall of the capillary tube is θ. Ignore the mass of water in the meniscus. Which of the following statements is (are) true?

(A) For a given material of the capillary tube, *h* decreases with increase in *r*

(B) For a given material of the capillary tube, *h* is independent of σ

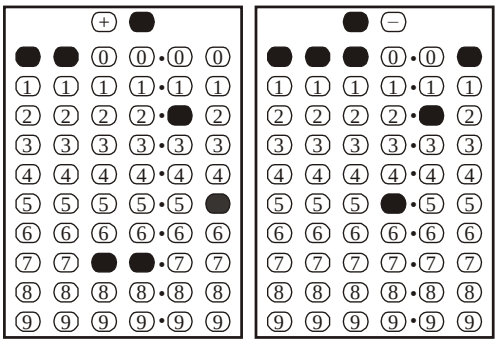
(C) If this experiment is performed in a lift going up with a constant acceleration, then *h* decreases

(D) *h* is proportional to contact angle θ.

PFM064

SECTION-III

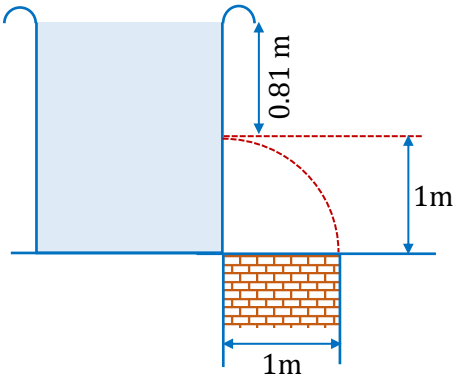
- This section contains **THREE** questions.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. 6.25, 7.00, –0.33, –.30, 30.27, –127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct) by darken the corresponding bubbles in the ORS.
  For Example : If answer is –77.25, 5.2 then fill the bubbles as follows:



- Answer to each question will be evaluated according to the following marking scheme:
  Full Marks : +3 if ONLY the correct numerical value is entered as answer.
  Zero Marks : 0 in all other cases.

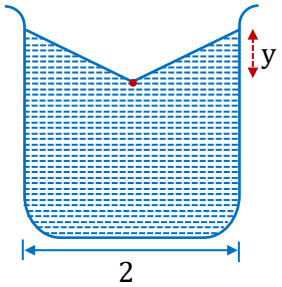
---

15. For the arrangement shown in the figure. The time interval in seconds after which the water jet ceases to cross the wall is found to be $(\alpha)^3$. Area of the cross section of the tank $A=\sqrt{5}m^2$ and area of the orifice a = 32 cm^2. [Assume that the container remaining fixed]. Find the value of α.
(Take g = 10 m/s^2)



PFM065

16. A container of width $2a$ is filled with a liquid. A thin wire of weight per unit length λ is gently placed over the liquid surface in the middle of the surface as shown in the figure. As a result, the liquid surface is depressed by a distance $y(y << a)$. The surface tension of the liquid is $\frac{\alpha\lambda ag}{2y}$. Find the value of α.



PFM066

17. A spherical ball of radius 1×10^{-4} m and density 10^4 kg/m^3 falls freely under gravity through a distance h before entering a tank of water. If after entering the water the velocity of the ball does not change, find h (in m). The viscosity of water is 9.8×10^{-6} $N\text{-}s/m^2$.

PFM067

SECTION-IV

- This section contains **ONE** question.
- Each question contains two columns, **Column-I** and **Column-II.**
- **Column-I** has **four** entries (A), (B), (C) and (D).
- **Column-II** has **four** entries (P), (Q), (R) and (S).
- Match the entries in **Column-I** with the entries in **column-II.**
- One or more entries in **Column-I** may match with one or more entries in **Column-II.**
- The ORS contains a 4 × 4 matrix whose layout will be similar to the one shown below:

(A) (P) (Q) (R) (S)
(B) (P) (Q) (R) (S)
(C) (P) (Q) (R) (S)
(D) (P) (Q) (R) (S)

- For each entry in **column-I,** darken the bubbles of all the matching entries. For example, if entry (A) in **Column-I** matches with entries (Q), (R) and (S), then darken these three bubbles in the ORS. Similarly, for entries (B), (C) and (D).
- For each question, marks will be awarded in <u>one of the following categories</u> :

For each entry in **Column-I**

Full Marks : +2 if only the bubble(s) corresponding to all the correct match(es) is (are) darkened.
Zero Marks : 0 if none of the bubbles is darkened.
Negative Marks : –1 in all other cases.

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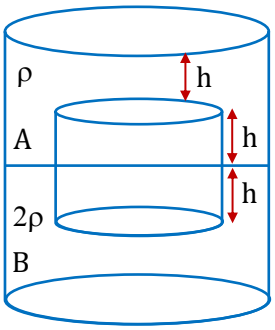
18. Shown below is a cylinder of radius R floating in vessel containing liquids A and B. Neglecting atmospheric pressure match the quantities mentioned in column-I with corresponding expression in column-II.



	Column-I		**Column-II**
(A)	Net force exerted by liquid A of density ρ on the cylinder.	(P)	$9\,\rho g R h^2$
(B)	Net force exerted by liquid B of density 2ρ on the cylinder.	(Q)	$\pi\rho g R^2 h$
(C)	Net force exerted by liquids A and B on the left half of the curved part of cylinder.	(R)	$4\pi\rho g R^2 h$
(D)	Net force exerted by liquid A and B on the cylinder.	(S)	$3\pi\rho g R^2 h$

PFM068

ANSWER KEY

EXERCISE - O

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	D	D	D	D	B	C	D	A	B	C
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	A	D	D	A	C	A	A	D	B	C
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	C	A	C	B	D	A	C	D	C	A
Que.	31	32	33	34	35	36	37	38	39	40
Ans.	C	B	D	B	C	B	C	A	B	B
Que.	41	42	43	44	45	46	47	48	49	50
Ans.	C	A	B	AD	AC	BC	AC	AD	AB	AC
Que.	51	52	53	54	55	56	57	58	59	60
Ans.	BD	C	A	B	C	BC	AD	B	B	D

EXERCISE - S

1. 37.5 N **2.** Nh **3.** 40.33 kPa **4.** 100.6 kPa

5. 1.55 m **6.** $P_0 + 3\rho gh$ **7.** $\frac{3l}{2}$ and $\frac{l}{2}$ **8.** $3m$

9. P_{atm} **10.** $P_0 - \rho a\ell$ **11.** 45°, 9600 $\sqrt{2}$ Pa **12.** $H = \frac{L^2\omega^2}{2g}$

13. $\frac{5d}{4}$ **14.** (a) 5, (b) 2/3 **15.** 45° **16.** 5

17. 2 **18.** + 29625 J/m^3, – 30000 J/m^3 **19.** 11

20. 108 **21.** 1.3 **22.** (i) $\frac{2}{10}$ m/s^2 (ii) $\sqrt{\frac{m_0 g}{2\rho A}}$

23. $5s$ **24.** 5 **25.** $\frac{dQ}{dt} \propto r^5$ **26.** 2.52 cm

27. $h = \frac{mg+4sa}{\rho_w a^2 g}$

EXERCISE - JEE (Main) PYQ

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	3	4	4	4	3	4	1	2	2	2
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	25	4	3	3	100m	29.4	363	4	25	3

EXERCISE - JEE (Advanced) PYQ

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	D	C	A	C	3	6	ACD	ACD	B	3.74
Que.	11	12	13	14	15	16	17	18	19	
Ans.	9	4	0.23 to 0.24	AC	0.30	10.00	B	CD	25	

JEE (Main) Practice Paper

Section-A	Q.	1	2	3	4	5	6	7	8	9	10
	A.	3	3	3	3	1	2	3	4	4	1
	Q.	11	12	13	14	15	16	17	18	19	20
	A.	4	2	1	2	2	3	2	1	1	3
Section-B	Q.	1	2	3	4	5	6	7	8	9	10
	A.	8	680	25	20	1	5	4	1	20	4

JEE (Advanced) Practice Paper

Section-I	Q.	1	2	3	4	5	6	7	8	9	10	11
	A.	C	B	A	D	B	B	D	D	D	D	C
Section-II	Q.	12	13	14								
	A.	D	AD	AC								
Section-III	Q.	15	16	17								
	A.	5	1	20.40								
Section-IV	Q.	18										
	A.	(A-Q), (B-R), (C-P), (D-S)										

Important Notes