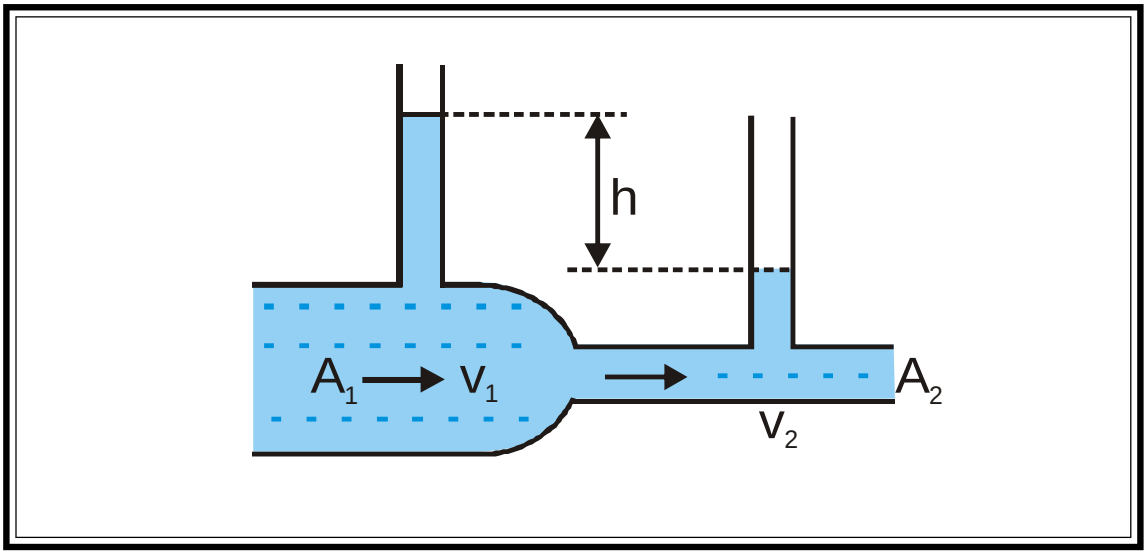
MATRIX

FOUNDATION PROGRAM

AJM PHYSICS

FLUID MACHANICS



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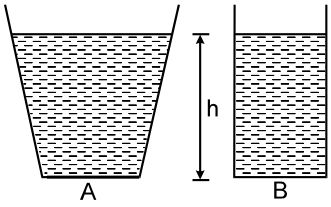
EXERCISE-I

MEASUREMENT AND CALCULATION OF PRESSURE

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

(A) 3.75 kg (B) 37.5 kg (C) 7.5 kg (D) 75 kg.

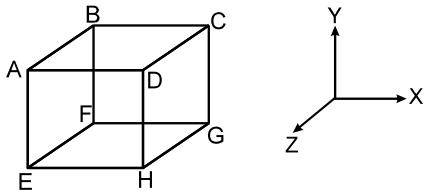
2. Two vessels A and B of different shapes have the same base area and are filled with water up to the same height h (see figure). The force exerted by water on the base is FA for vessel A and FB for vessel B. The respective weights of the water filled in vessels are WA and WB. Then



(A) FA > FB ; WA > WB (B) FA = FB ; WA > WB

(C) FA = FB ; WA < WB (D) FA > FB ; WA = WB

3. The cubical container ABCDEFGH which is completely filled with an ideal (nonviscous and incompressible) fluid, moves in a gravity free space with a acceleration of $a = a_0 (\hat{i} - \hat{j} + \hat{k})$ where a_0 is a positive constant. Then the only point in the container where pressure is maximum, is



(A) B (B) C (C) E (D) F

4. Following are some statements about buoyant force: (Liquid is of uniform density)

(i) Buoyant force depends upon orientation of the concerned body inside the liquid.

(ii) Buoyant force depends upon the density of the body immersed.

(iii) Buoyant force depends on the fact whether the system is on moon or on the earth.

(iv) Buoyant force depends upon the depth at which the body (fully immersed in the liquid) is placed inside the liquid.

Of these statements :

(A) Only (i), (ii) and (iv) are correct. (B) Only (ii) is correct.

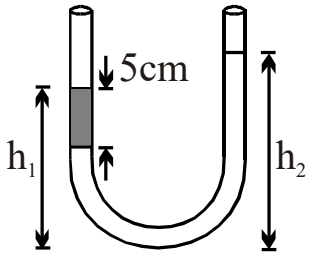
(C) Only (iii) and (iv) are correct. (D) (i), (ii) and (iv) are incorrect.

5. To construct a barometer, a tube of length 1 m is filled completely with mercury and is inverted in a mercury cup. The barometer reading on a particular day is 76 cm. Suppose a 1 m tube is filled with mercury up to 76 cm. It is inverted in a mercury cup. The height of mercury column in the tube over the surface in the cup will be

(A) zero (B) 76 cm

(C) > 76 cm (D) < 76 cm

6. 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?



(A) 3/1 (B) 5/2 (C) 2/1 (D) 3/2

ARCHEMEDIES PRINCIPLE AND FORCE OF BUOYANCY

7. A cubical block of wood of edge 10cm and mass 0.92kg floats on a tank of water with oil of rel. density 0.6 to a depth of 4cm above water. When the block attains equilibrium with four of its sides edges vertical :

(A) 1 cm of it will be above the free surface of oil.

(B) 5 cm of it will be under water.

(C) 2 cm of it will be above the common surface of oil and water.

(D) 8 cm of it will be under water.

8. A block weighs 15 N in air and 12 N when immersed in water. The specific gravity of the block is :

(A) 0.8 (B) 0.25 (C) 5/4 (D) 5

9. The reading of a spring balance when a block is suspended from it in air is 60 newton. This reading is changed to 40 newton when the block is submerged in water. The specific gravity of the block must be therefore :

(A) 3 (B) 2 (C) 6 (D) 3/2

10. We have two different liquids A and B whose relative densities are 0.75 and 1.0 respectively. If we dip solid objects P and Q having relative densities 0.6 and 0.9 in these liquids, then :

(A) P floats in A and Q sink in B (B) P sinks in A and Q floats in B

(C) P floats in B and Q sinks in A (D) P sinks in B and Q floats in A

11. A body measures 5 N in air and 2 N when put in water. The buoyant force is :
(A) 7 N (B) 9 N
(C) 3 N (D) none of these

12. A body of uniform cross-sectional area floats in a liquid of density thrice its value. The portion of exposed height will be :
(A) 2/3 (B) 5/6
(C) 1/6 (D) 1/3

13. A boat 3 m long 2 m wide is floating in a lake. When a man climbs over it, it sinks 1 cm into the lake. The mass of the man is
(A) 60 kg (B) 64 kg
(C) 70 kg (D) 72 kg

14. A boat with scrap iron is floating in a lake. If the scrap iron is thrown in the lake, the water level will
(A) go up (B) go down
(C) remain unchanged (D) none of these

15. A boat floating in a tank is carrying passengers. If the passengers drink water, how will it affect the water level of the tank?
(A) it will go down (B) it will rise
(C) it will remain unchanged (D) it will depend on atmospheric pressure

CONTINUITY EQUATION AND BERNOULLI THEOREM & THEIR APPLICATION

16. The total area of cross–section is 0.25 m2. If the blood is flowing at the rate of 100 cm3/sec, then the average velocity of flow of blood through the capillaries is :
(A) 0.4 mm/sec. (B) 4 mm/sec.
(C) 25 mm/sec. (D) 400 mm/sec.

17. An incompressible fluid flows steadily through a cylindrical pipe which has radius 2R at point A and radius R at point B further along the flow direction. If the velocity at point A is v, its velocity at point B will be :
(A) 2v (B) v
(C) v/2 (D) 4v

18. Water is flowing through a horizontal pipe of non-uniform cross-section. At the extreme narrow portion of the pipe, the water will have :
(A) maximum speed and least pressure
(B) maximum pressure and least speed
(C) both pressure and speed maximum
(D) both pressure and speed least

19. An aeroplane gets an upward lift due to a phenomenon best described by the :

(A) Archimedes's principle (B) Bernoulli's principle

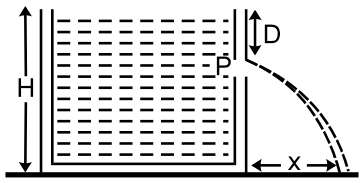
(C) Buoyancy principle (D) Pascal's law

20. In Bernoulli's theorem which of the following is conserved ?

(A) Mass (B) Energy

(C) Linear momentum (D) Angular momentum

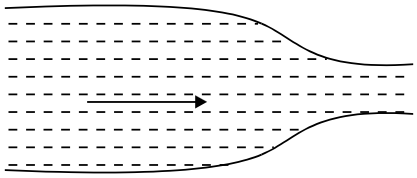
21. A tank is filled with water up to height H. Water is allowed to come out of a hole P in one of the walls at a depth D below the surface of water. Express the horizontal distance x in terms of H and D :

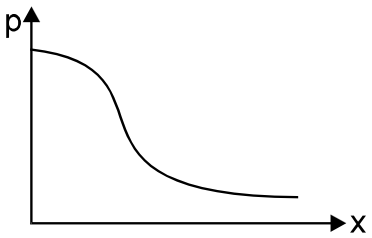


(A) $x = \sqrt{D(H-D)}$ (B) $x = \sqrt{\frac{D(H-D)}{2}}$

(C) $x = 2\sqrt{D(H-D)}$ (D) $x = 4\sqrt{D(H-D)}$

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



(A)


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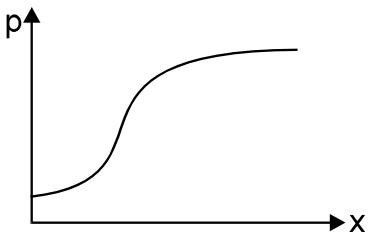
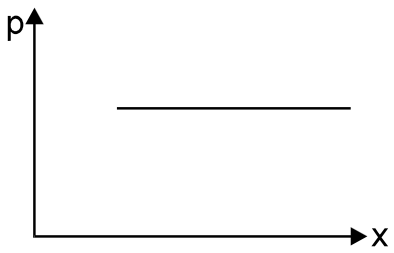
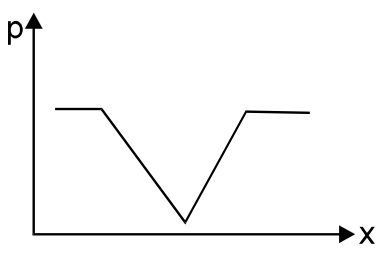
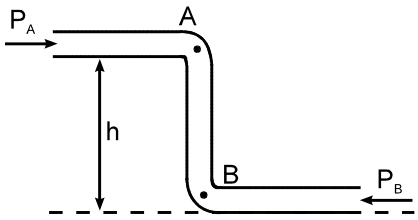


(C)


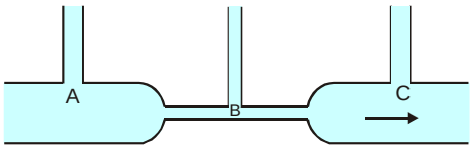
(D)


23. Figure shows an ideal fluid flowing through a uniform cross-sectional tube in the vertical tube with liquid velocities vA & vB and pressure PA & PB. Knowing that tube offers no resistance to fluid flow following is true.



(A) PB > PA (B) PB < PA (C) PA = PB (D) none of these

24. In the figure below is shown the flow of liquid through a horizontal pipe. Three tubes A, B and C are connected to the pipe. The radii of the tubes, A, B and C at the junction are respectively 2 cm, 1 cm. and 2 cm. It can be said that the :–



(A) Height of the liquid in the tube A is maximum

(B) Height of the liquid in the tubes A and B is the same

(C) Height of the liquid in all the three tubes is the same

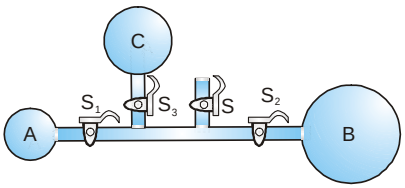
(D) Height of the liquid in the tubes A and C is the same

25. A tank of height 5 m is full of water. There is a hole of cross sectional area 1 cm2 in its bottom. The initial volume of water that will come out from this hole per second is :–

(A) 10–3 m3/s (B) 10–4 m3/s (C) 10 m3/s (D) 10–2 m3/s

PROPERTIES OF FLUID

26. The adjoining diagram shows three soap bubbles A, B and C prepared by blowing the capillary tube fitted with stop cocks S, S_1, S_2 and S_3 with stop cock S closed and stop cocks S_1, S_2 and S_3 opened :–



(A) B will start collapsing with volumes of A and C increasing

(B) C will start collapsing with volumes of A and B increasing

(C) C and A will both start collapsing with the volume of B increasing

(D) Volumes of A, B and C will become equal at equilibrium

27. A liquid drop of diameter D breaks into 27 tiny drops. The resultant change in energy is :–

(A) $2p\ TD^2$ (B) $4p\ TD^2$

(C) $p\ TD^2$ (D) None of these

28. An air bubble is lying just below the surface of water. The surface tension of water is $70 \times 10^{-3}\ Nm^{-1}$ and atmospheric pressure is $1.013 \times 105\ Nm^{-2}$. If the radius of bubble is 1 mm, then the pressure inside the bubble will be :–

(A) 1.0270×10^5 Pa (B) 1.0160×10^5 Pa

(C) 1.0144×10^5 Pa (D) 1.0131×10^5 Pa

29. Pressures inside two soap bubbles are 1.01 and 1.02 atmospheres. Ratio between their volumes is :–

(A) 102 : 101 (B) (102)3 : (101)3

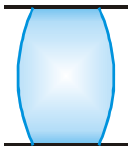
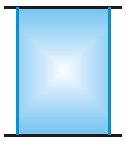
(C) 8 : 1 (D) 2 : 1

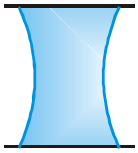
30. Shape of meniscus for a liquid of zero angle of contact is :–

(A) Plane (B) Parabolic

(C) Hemi–spherical (D) Cylindrical

31. If a water drop is kept between two glass plates, then its shape is :–

(A)  (B) 

(C)  (D) None the these

32. Two capillary tubes of same diameter are put vertically one each in two liquids whose relative densities are 0.8 and 0.6 and surface tensions are 60 dyne/cm and 50 dyne/cm respectively. Ratio of heights of liquids in the two tubes is :–

(A) $\frac{10}{9}$ (B) $\frac{3}{10}$

(C) $\frac{10}{3}$ (D) $\frac{9}{10}$

33. In a capillary tube experiment, a vertical 30 cm long capillary tube is dipped in water. The water rises up to a height of 10 cm due to capillary action. If this experiment is conducted in a freely falling elevator, the length of the water column becomes :–

(A) 10 cm (B) 20 cm

(C) 30 cm (D) Zero

34. Water rises to a height of 16.3 cm in a capillary of height 18 cm above the water level. If the tube is cut at a height of 12 cm :–

(A) Water will come as a fountain from the capillary tube

(B) The height of the water in the capillary will be 12 cm

(C) The height of the water in the capillary will be 16.3 cm

(D) Water will flow down in it's arms

35. Water rises in a capillary upto a height h. If now this capillary is tilted by an angle of 45°, then the length of the water column in the capillary becomes :–

(A) 2h (B) $\frac{h}{2}$

(C) $\frac{h}{\sqrt{2}}$ (D) $h\sqrt{2}$

36. The side of glass aquarium is 1 m high and 2 m long. When the aquarium is filled to the top with water, what is the total force against the side–

(A) 980×10^3 N (B) 9.8×10^3 N

(C) 0.98×10^3 N (D) 0.098×10^3 N

37. A rain drop of radius 0.3 mm has a terminal velocity in air 1m/s. The viscosity of air is 18×10^{-5} poise. The viscous force on it is :–

(A) 101.73×10^{-4} dyne (B) 101.73×10^{-5} dyne

(C) 16.95×10^{-5} dyne (D) 16.95×10^{-4} dyne

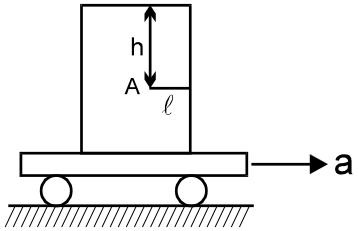
38. A copper ball of radius 'r' travels with a uniform speed 'v' in a viscous fluid. If the ball is changed with another ball of radius '2r', then new uniform speed will be :–

(A) v (B) 2v

(C) 4v (D) 8v

EXERCISE-II

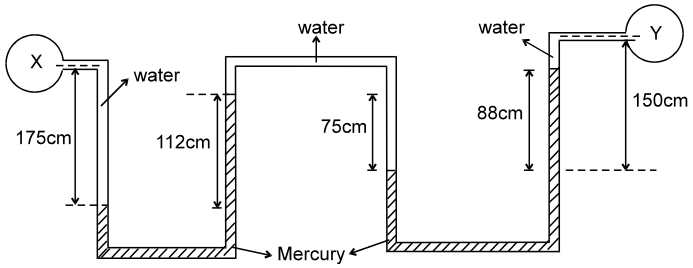
1. A cart supports a cubic tank filled with a liquid of density r up to its top. The cart moves with a constant acceleration 'a'. Determine the pressure at point 'A' which is at a depth 'h' and a distance l from the front wall, if the tank is tightly closed with a lid. In uniform motion the lid does not exert any pressure on the liquid.



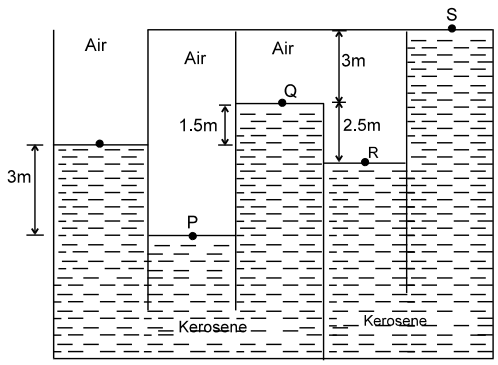
2. A hydraulic press has a ram (weight arm) 12.5 cm in diameter and plunger (Force arm) of 1.25 cm diameter. What force would be required on the plunger to raise a weight of 1 tonn on the ram.

3. Pressure 3 m below the free surface of a liquid is 15KN/m^2 in excess of atmosphere pressure. Determine its density and specific gravity. [g = 10 m/sec^2]

4. Two U-tube manometers are connected in series as shown in figure. Determine difference of pressure between X and Y. Take specific gravity of mercury as 13.6.



5. The container shown below holds kerosene and air as indicated. Compute the pressure at P, Q, R and S in KN/m2 Take specific gravity of kerosene as 0.8.



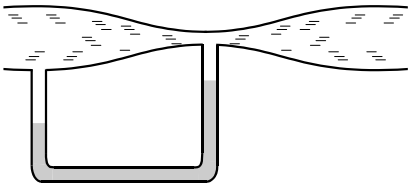
6. A cube of wood supporting a 200 gm mass just floats in water. When the mass is removed the cube rise by 2 cm. Find the size of cube

7. A rod of length 6 m has a mass of 12 kg. If it is hinged at one end at a distance of 3 m below a water surface,
(i) What weight must be attached to the other end of the rod so that 5 m of the rod is submerged?
(ii) Find the magnitude and direction of the force exerted by the hinge on the rod. The specific gravity of the material of the rod is 0.5.

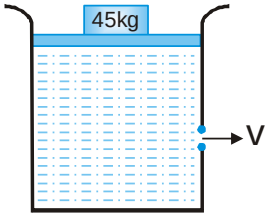
8. A liquid is kept in a cylindrical vessel which is rotated along its axis. The liquid rises at the sides. If the radius of the vessel is 0.05 m and the speed of rotation is 2 rev per sec. Find the difference in the height of the liquid at the centre of the vessel and at its sides.

9. The pressures of water in a water pipe when tap is open and closed are respectively 3×10^5 N/m^2 and 3.5×10^5 N/m^2. If tap is opened, then find out-
(a) velocity of water flowing
(b) rate of volume of water flowing if area of cross-section of tap is 2 cm^2.

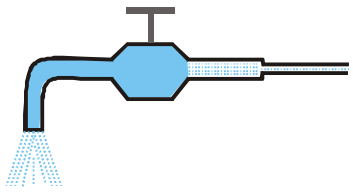
10. Water flows through the tube shown in figure. The areas of cross-section of the wide and the narrow portion of the tube are 5 cm2 and 2 cm^2 respectively. The rate of flow of water through the tube is 500 cm^3/s. Find the difference of mercury levels in the U-tube. (density of mercury = 13.6 gm/cm^3)



11. 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. The value of v when piston is 7m above the bottom is (g = 10 m/s^2) _____ .

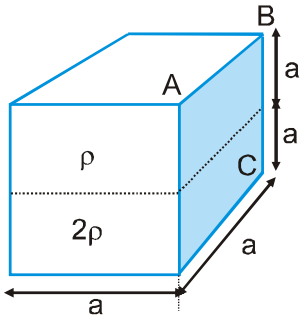


12. The pressure of water in a water pipe when tap is opened and closed is respectively 3×10^5 Nm^{-2} and 3.5×10^5 Nm^{-2}. With open tap, the velocity of water flowing is _____ .

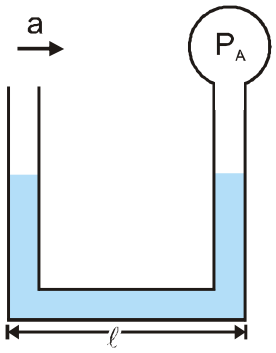


13. During blood transfusion the needle is inserted in a vein where the gauge pressure is 2000 Pa. At what height must the blood container be placed so that blood may just enter the vein ?
[density of whole blood = 1.06×10^3 kg m^{-3}].

14. A cuboid (a × a × 2a) is filled with two immiscible liquids of density 2ρ & ρ as shown in the figure. Neglecting atmospheric pressure, ratio of force on base & side wall of the cuboid is_____ .



15. A liquid of density ρ is filled in a U-tube, whose one end is open & 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 motion it is found that liquid in both column is at same level at equilibrium. If atmospheric pressure is P_0, then value of P_A is _____ .

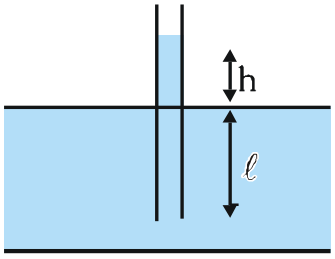


16. A hole is made at the bottom of a large vessel open at the top. If water is filled to a height h, it drains out completely in time t. The time taken by the water column of height 2h to drain completely is_____ .

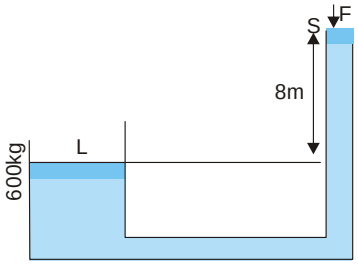
17. A flat plate moves normally with a speed v_1 towards a horizontal jet of water of uniform area of cross-section. The jet discharges water at the rate of volume V per second at a speed of v_2. The density of water is ρ. Assume that water splashes along the surface of the plate at right angles to the original motion. The magnitude of the force acting on the plate due to jet of water is _____ .

18. A square plate of 1m side moves parallel to a second plate with velocity 4 m/s. A thin layer of water exist between plates. If the viscous force is 2 N and the coefficient of viscosity is 0.01 poise then find the distance between the plates in mm.

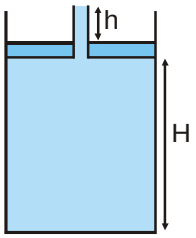
19. The capillary tube is dipped in water vertically. It is sufficiently long so that water rises to maximum height h in the tube. The length of the portion immersed in water is $\ell > h$. The lower end of the tube is closed, the tube is taken out and opened again. Then, find the length of the water column remaining in the tube.



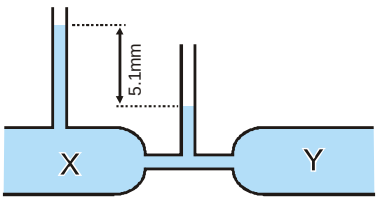
20. For the system shown in the figure, the cylinder on the left at L has a mass of 600 kg and a cross sectional area of 800 cm^2. The piston on the right, at S, has cross sectional area 25 cm^2 and negligible weight. If the apparatus is filled with oil ($\rho = 0.75$ gm/cm^3) Find the force F required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



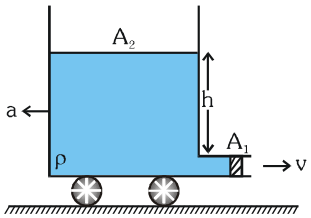
21. A piston of mass M=3kg and radius R=4cm has a hole into which a thin pipe of radius r = 1cm is inserted. The piston can enter a cylinder tightly and without friction, and initially it is at the bottom of the cylinder. 750 gm of water is now poured into the pipe so that the piston & pipe are lifted up as shown. Find the height H of water in the cylinder and height h of water in the pipe.



22. The diagram shows venturimeter through which water is flowing. The speed of water at X is 2 cm/sec. Find the speed of water at Y (taking g = 1000 cm/sec^2).

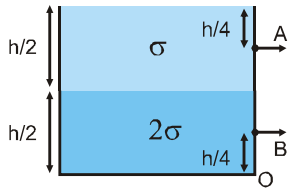


23. In a movable container shown in figure a liquid of density ρ is filled up to a height h. The upper & lower tube cross sectional areas are A_2 & A_1 respectively ($A_2 >> A_1$). If the liquid leaves out the container through the tube of cross–sectional area A_1 then find –



(i) Velocity of liquid coming out. **(ii)** Backward acceleration of the container.

24. A large tank is filled with two liquids of specific gravities 2σ and σ. Two holes are made on the wall of the tank as shown. Find the ratio of the distance from O of the points on the ground where the jets from holes A & B strike.

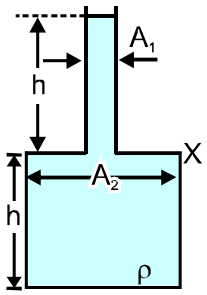


25. A spherical ball of radius 3×10^{-4} m and density 10^4 kg/m^3 falls freely under gravity through a distance h before entering a tank of water. If after entering the water the velocity of the ball does not change, find h. The viscosity of water is 9.8×10^{-6} N–s/m^2.

26. There is a 1mm thick layer of glycerine between a flat plate of area 100 cm^2 and a big plate. If the coefficient of viscosity of glycerine is 1.0 kg/m–sec, then how much force is required to move the plate with a velocity of 7 cm/sec.

MULTIPLE CHOICE QUESTION

27. The vessel shown in the figure has two sections of areas of cross–section A_1 and A_2. A liquid of density ρ fills both the sections, up to a height h in each. Neglect atmospheric pressure:-



(A) The pressure at the base of the vessel is 2hρg.

(B) The force exerted by the liquid on the base of the vessel is $2h\rho gA_2$.

(C) The weight of the liquid is $< 2h\rho gA_2$.

(D) The walls of the vessel at the level X exert a downward force $h\rho g(A_2 - A_1)$ on the liquid.

28. When a capillary tube is dipped in a liquid, the liquid rises to a height h in the tube. The free liquid surface inside the tube is hemispherical in shape. The tube is now pushed down so that the height of the tube outside the liquid is less than h:-

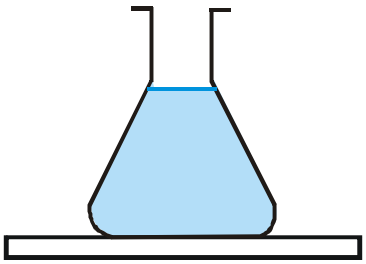
(A) The liquid will come out of the tube like in a small fountain.

(B) The liquid will ooze out of the tube slowly.

(C) The liquid will fill the tube but not come out of its upper end.

(D) The free liquid surface inside the tube will not be hemispherical.

29. A massless conical flask filled with a liquid is kept on a table in a vacuum. The force exerted by the liquid on the base of the flask is W_1. The force exerted by the flask on the table is W_2.



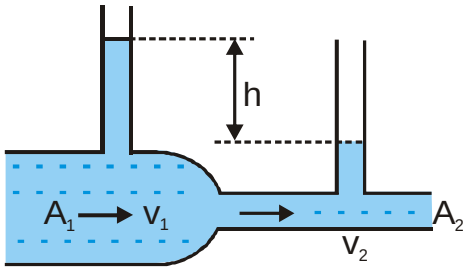
(A) $W_1 = W_2$

(B) $W_1 > W_2$

(C) $W_1 < W_2$

(D) The force exerted by the liquid on the walls of the flask is $(W_1 - W_2)$.

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



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

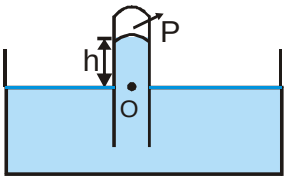
(B) $v_2 - v_1 = \sqrt{2gh}$

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

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

MATCH THE COLUMN

31. A tube is inverted in a mercury vessel as shown in figure. If pressure P is increased, then :



Column I	**Column II**
(A) Height h	(P) will increase
(B) Pressure at O	(Q) will decrease
(C) Pressure at 1 cm above O	(R) will remain same

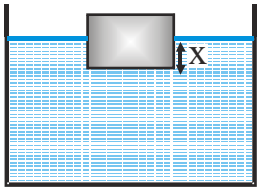
32. Two soap bubbles coalesce to form a single large bubble.:

Column I	**Column II**
(A) Surface energy in the process will	(P) increase
(B) Temperature of the bubble will	(Q) decrease
(C) Pressure inside the soap bubble will	(R) remains same

33. A solid is immersed completely in a liquid. The coefficients of volume expansion of solid and the liquid are γ_1 and γ_2 ($<\gamma_1$). If temperatures of both are increased, then

Column I	**Column II**
(A) Upthrust on the solid will	(P) increase
(B) apparent weight of the solid will	(Q) decrease
(C) Fraction of volume immersed in the liquid if allowed to float	(R) remains same

34. A cube is floating in a liquid as shown in figure.



Column I	**Column II**
(A) If density of liquid decreases then x will	(P) increase
(B) If size of cube is increased then x will	(Q) decrease
(C) If the whole system is accelerated upwards then x will	(R) remains same

EXERCISE-III

OLYMPIAD EXAMS PREVIOUS YEARS' QUESTIONS :

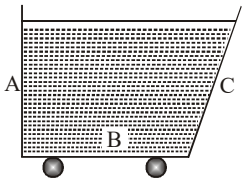
1. A liquid flowing with speed v through a horizontal pipe of cross sectional area A enters into another pipe of double the area of cross section. Now, the speed of the liquid is : **(IAO/Jr./Stage-I/2007)**

   (A) v (B) 2 v (C) v/2 (D) v/4

2. A rubber balloon of negligible mass is filled with 500 g of water. Its weight in water will be : **(IAO/Jr.Stage-I/2007)**

   (A) 250 g (B) 500 g (C) zero (D) 100 g

3. A buggy ABC of shape as shown in the figure is filled with water. Which of the following statements is NOT correct ? **(IAO/Jr./Stage-I/2008)**



   (A) Average pressure on surfaces A and C is the same.

   (B) Pressure on surface B is greater than average pressure on surface A.

   (C) Force due to hydrostatic pressure on surface C is greater than that on surface A.

   (D) The buggy moves to the right on its own.

4. There is a steady water flow in a horizontal tube in which one part has cross sectional area A_1 and the other part has cross sectional area A_2. Assume that water is incompressible.

   If $A_1/A_2 = 16$, the ratio of the speed u_1 in part 1 and the speed u_2 in part 2, i.e. u_1/u_2 is : **(KVPY/2008)**

   (A) $\frac{1}{16}$ (B) 4 (C) $\frac{1}{4}$ (D) 1

5. An iceberg is floating in ocean. What fraction of its volume is above the water ?

   (Given : density of ice = 900 kg/m^3 and density of ocean water = 1030 kg / m^3) **(IAO/Jr./Stage-I/2008)**

   (A) 90 / 103 (B) 13 / 103

   (C) 10 / 103 (D) 1 / 103

6. An air bubble situated at the bottom of an open kerosene tank rises to the top surface. It is observed that at the top the volume of the bubble is thrice its initial volume. If the atmospheric pressure is 72 cm of Hg, and mercury is 17 times heavier than kerosene, the depth of the tank must be : **(IAO/Jr./Stage-I/2008)**

   (A) 2.16 m (B) 2.88 m (C) 12.24 m (D) 24.48 m

7. A block of wood is floating on oil with half of its volume submerged. If the density of oil 840 kg m^{-3}, the relative density of wood (relative to water) is : **(KVPY/2008)**

   (A) 0.84 (B) 0.42 (C) 0.21 (D) 1.00

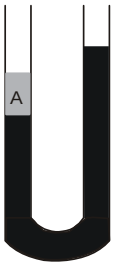
8. A rubber pipe with a diameter of 10 cm is connected to a nozzle 2 cm in diameter. Water flowing through the pipe at a speed of 0.6 ms^{-1} comes out like a jet through the nozzle. The backward force of the nozzle is about : **(KVPY/2008)**

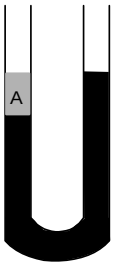
(A) 7.7 N (B) 67.9 N (C) zero (D) 2.8 N

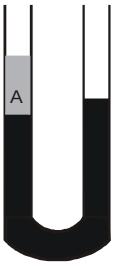
9. A beaker containing water is placed on the platform of a digital weighing machine. It reads 1100 g. A metal body of density 8g /cc and mass 200 g is suspended in water in the beaker (without touching the walls of the beaker). It is attached by a suitable string fixed to some support. Now the reading of weighing machine will be : **(IJSO/Stage-I/2009)**

(A) 1100g (B) 1125 g (C) 1275 (D) 1300 g

10. Two immiscible liquids, A and B are kept in a U-tube. If the density of liquid A is smaller than the density of liquid B, then the equilibrium situation is: **(KVPY/2009)**

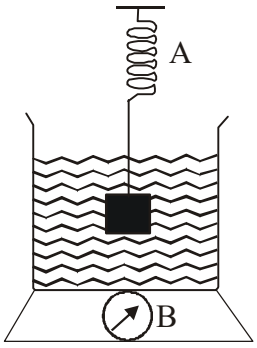
(A) 

(B) 

(C) 

(D) None of these

11. A spring balance A reads 2 kg with a block of mass m suspended from it. Another balance B reads 3 kg when a beaker with a liquid is put on its pan. The two balances are now so arranged that the hanging mass m is fully immersed inside the liquid in the beaker as shown in the figure. In this situation. **(KVPY/2009)**



(A) the balance A will read 2 kg and B will read 5 kg.

(B) the balance A will read 2 kg and B will read 3 kg.

(C) the balance A will read less than 2 kg and B will read between 3 kg and 5 kg.

(D) the balance A will read less than 2 kg and B will read 3 kg.

12. We sit in the room with windows open. Then : **(KVPY/2011)**

(A) Air pressure on the floor of the room equals the atmospheric pressure but the air pressure on the ceiling is negligible

(B) Air pressure is nearly the same on the floor, the walls and ceiling

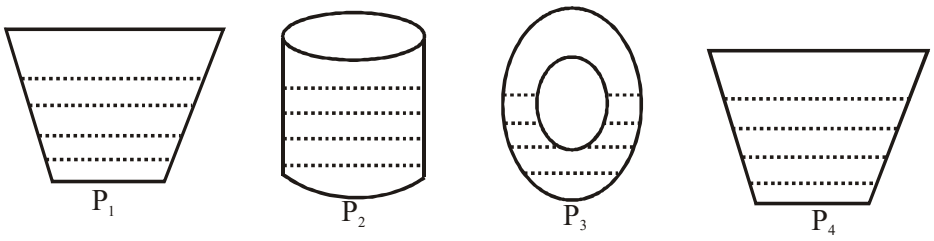
(C) Air pressure on the floor equals the weight of the air column inside the room (from floor to ceiling) per unit area

(D) Air pressure on the walls is zero since the weight of air acts downward

13. A conical vessel of radius 6 cm and height 8 cm is completely filled with water. A metal sphere is now lowered into the water. The size of the sphere is such that when it touches the inner surface, it just gets immersed. The fraction of water that overflows from the conical vessel is **[NSEJS 2011-12]**

(A) $\frac{3}{8}$ (B) $\frac{5}{8}$ (C) $\frac{7}{8}$ (D) $\frac{5}{16}$

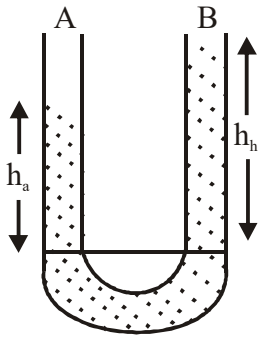
14. The pressure at the bottom of the four vessels filled with water to the same level is P_1, P_2, P_3 and P_4 respectively. The which of the following conclusion is correct. **[NSEJS 2012-13]**



(A) $P_1 > P_2 > P_3 > P_4$ (B) $P_1 < P_2 < P_3 < P_4$

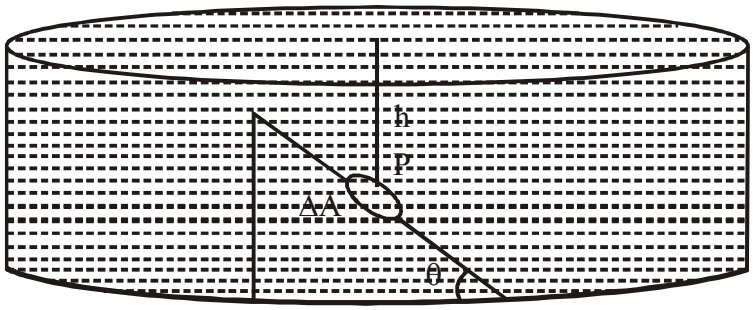
(C) $P_1 = P_4 = P_2 > P_3$ (D) $P_1 = P_2 = P_3 = P_4$

15. A liquid (A) of density 1.6 gcm^{-3} and liquid (B) of unknown density is poured into a U-tube as shown in the figure. The liquids are immiscible. If height of A is $h_A = 26.6$ cm and of B is $h_B = 50$cm the density of B is **[NSEJS 2013-14]**



(A) 0.85 g cm^{-3} (B) 3.01 g cm^{-3} (C) 0.33 g cm^{-3} (D) 1.18 g cm^{-3}

16. An inclined plane of inclination θ is placed in water as shows in figure given below. Consider a small area (ΔA) around point P at a depth h. If Density of water is ρ and and acceleration due to gravity is g the force experienced by ΔA due to hydrostatic pressure is **[NSEJS 2013-14]**



(A) ρgh (ΔA) cosθ (B) pgh (ΔA) sinθ

(C) pgh (ΔA) (D) ρgh (ΔA) secθ

17. An inflated ballon with a heavy rock tied to it submerges in water. As the sinks deeper and deeper, the buoyant force acting on it **[NSEJS 2014-15]**

(A) increases (B) decreases

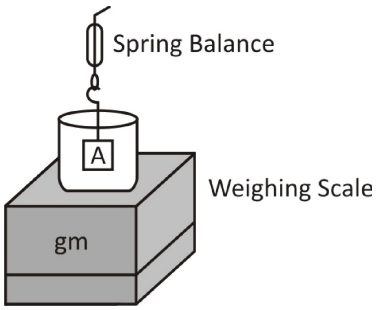
(C) remains nearly unchanged (D) initally increases and then decreases

18. Three identical vessels carrying equal amount of water are placed in three lifts. Lift A is accelerating upwards. lift B is accelerating downwards while lift C is moving up with constant velocity. The pressure at a depth h from surface in the three vessel is measured as p_A, p_B with p_C then which of the following is ture **[NSEJS 2014-15]**

(A) $p_A = p_c > p_8$ (B) $p_A > p_c > p_8$

(C) $p_A > p_c = p_8$ (D) $p_A = p_c = p_8$

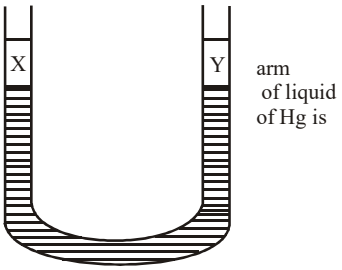
19. Object A is completely immmersed in water. True weight of object A is W_A. Weight of water with beaker is W_B. Let B be the buoyant force. W_1 and W_2 are scale readings of spring balance and weighing scale respectively



[NSEJS 2016-17]

(A) $W_1 = W_A$ (B) $W_1 = W_A + B$ (C) $W_2 = W_5$ (D) $W_2 = W_B + B$

20. U-tube contains some amount of mercury. Immiscible liquid X is poured in left immiscible liquid Y is poured in the right arm. length of liquid X is 8 cm, length Y is 10 cm and upper levels of X and Yare equal. If density of Y is 3.36 g·cm-3 and 13.6 g·cm-3 then density of X is **[NSEJS 2016-17]**



(A) 0.8 g-cm^{-3} (B) 1.2 g·cm^{-3} (C) 1.4 g·cm^{-3} (D) 1.6 g. cm^{-3}

21. A liquid, whose density doesn't change during the motion, is flowing steadily through a pipe of varying cross sectional area as shown in the given figure. If a_1, a_2 are the cross sectional areas, v_1, v_2 are the values of velocities (or speeds) at L and H respectively, then the correct relation between a_1, a_2 and v_1, v_2 is **[NSEJS 2017-18]**

(A) $a_1v_1 = a_2v_2$ (B) $a_1v_2 = a_2v_1$, (C) $a_1^2v_2 = a_2^2v_1$ (D) $a_1v_1^2 = a_2v_2^2$

22. Consider the motion of a small spherical steel body of mass m, falling freely through a long column of a fluid that opposes its motion with a force proportional to its speed. Initially the body moves down fast, but after some time attains a constant velocity known as terminal velocity. If weight mg, opposing force (Fv) and buoyant force (Fb) act on the body, then the correct equation relating these forces, after the terminal velocity is reached, is:

[NSEJS 2019-20]

(A) $mg + F_V = F_b$ (B) $mg = F_V - F_b$

(C) $mg = F_V + F_b$ (D) None

23. A piece of ice is floating in water at 4°C in a beaker. When the ice melts completely, the water level in the beaker will **[NSEJS 2019-20]**

(A) Rise (B) Fall

(C) Remains unchanged (D) Unpredictable

24. A block of wood floats on water with $\left(\frac{3}{8}\right)^{th}$ of its volume above water. It is now made to float on a salt solution of relative density 1.12. The fraction of its volume that remains above the salt solution now, is nearly _____ . **[NSEJS 2019-20]**

(A) 0.33 (B) 0.44

(C) 0.67 (D) 0.56

25. The tympanic membrane (ear drum) is a very delicate component of the human ear. Typically, its diameter is 1 cm. the maximum force the ear an withstand is 2.5 N. In caase a diver has to enter sea water of density 1.05×10^3 kg/m^3 without any protective gear, the maximum safe depth for the diver to go into water is about **[NSEJS 2020-21]**

(A) 12 m (B) 9 m

(C) 3 m (D) 1.5 m

26. A vessel contains a liquid - 1 of density 0.8 gm/ cm^3 over a liquid - 2 of density 13.6 gm/cm^3. The two liquids are immiscible. A homogeneous solid sphere with half if its immersed in liquid - 1 and other half in liquid –2. Then density of the material of the sphere in gm/cm^3 is : **[NSEJS 2022-23]**

(A) 3.3 (B) 6.4

(C) 7.2 (D) 12.8

27. One fine morning, Mr. Ravi visited Gandhi park with his grandson. When he was just on a bridge over the lake in the park, an old wooden toy 'just' dropped from his hand. The toy went straight down to hit surface of calm water, then sinked into water to a certain depth below water surface and returns back due to upthrust of water to the hands of Mr.Ravi in the same position from where it was dropped. Assuming this position to be at height 19. 6 meter above the surface of water, and density of material of toy to be just half the density of water in lake, the total time in which toy is received back to the hand of Mr. Ravi is calculated to be **[NSEJS 2022-23]**

(A) 2 second (B) 4 second

(C) 8 second (D) 16 second

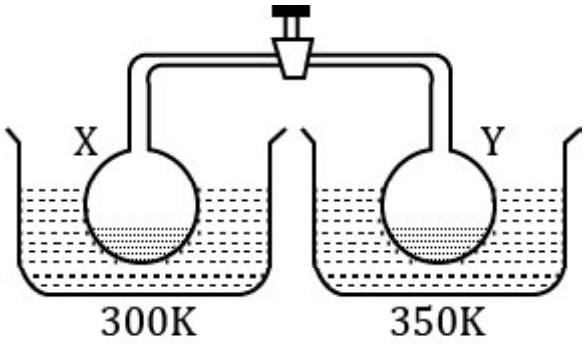
28. A tank with a square base of area 2. 0 *meter*^{2} is divided by a vertical partition in the middle. The bottom of the partition has a small hinged door of area 10 *cm*^{2}. The tank is filled with water in one compartment and a liquid of relative density 1. 8 in other compartment, both to a height 5. 0 meter. The force necessary to keep the door close is approximately (g = 9. 8 *m*/*s*^{2}) **[NSEJS 2022-23]**

(A) 0.04 *N* (B) 3.9 *N*

(C) 39 *N* (D) Zero

29. Two containers each containing water in liquid state are connected by a valve as shown in the diagram

[NSEJS 2022-23]



Given that vapour pressure of water at 300*K* and 350*K* are 22 torr and 40 torr, select correct statement(s):

(A) The final pressure in each container after the valve is opened, while keeping the containers at their respective temperatures, is equal but more than 22 torr.

(B) The final pressure in each container after the vale is opened, while keeping the containers at their respective temperatures, is 40 torr.

(C) Mass of water is decreased in container *X*.

(D) Mass of water is decreased in container *Y*.

EXERCISE-IV

1. A rectangular film of liquid is extended from (4 cm × 2 cm) to (5 cm × 4 cm). If the work done is 3×10^{-4} J, the value of the surface tension of the liquid is - **[NEET 2016]**

(A) 0.125 N m^{-1} (B) 0.2 N m^{-1}

(C) 8.0 N m^{-1} (D) 0.250 N m^{-1}

2. Three liquids of densities ρ_1, ρ_2 and ρ_3 (with $\rho_1 > \rho_2 > \rho_3$), having the same value of surface tension T, rise to the same height in three identical capillaries. The angles of contact θ_1, θ_2 and θ_3 obey - **[NEET 2016]**

(A) $0 \le \theta_1 < \theta_2 < \theta_3 < \frac{\pi}{2}$ (B) $\frac{\pi}{2} < \theta_1 < \theta_2 < \theta_3 < \pi$

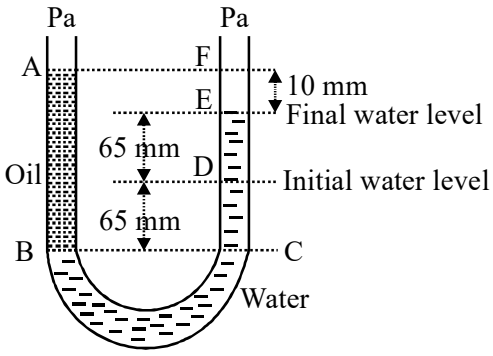
(C) $\pi > \theta_1 > \theta_2 > \theta_3 > \frac{\pi}{2}$ (D) $\frac{\pi}{2} > \theta_1 > \theta_2 > \theta_3 \ge 0$

3. Two non-mixing liquids of densities ρ and nρ(n > 1) are put in a container. The height of each liquid is h. A solid cylinder of length L and density d is put in this container. The cylinder floats with its axis vertical and length pL(p < 1) in the denser liquid. The density d is equal to - **[NEET 2016]**

(A) {1 + (n + 1)p}ρ (B) {2 + (n + 1)p}ρ

(C) {2 + (n – 1)p}ρ (D) {1 + (n – 1)p}ρ

4. A U tuve with both ends open to the atomsphere is partially filled with water. Oil, which is immiscible with water, is poured into one side until it stands at a distance of 10 mm above the water level on the other side Meanwhile the water rises by 65 mm from its original level (see diagram) The density of the oil is - **[NEET 2017]**



(A) 650 kg m^{-3} (B) 425 kg m^{-3} (C) 800 kg m^{-3} (D) 928 kg m^{-3}

5. A soap bubble, having radius of 1 mm, is blown from a detergent solution having a surface tension of 2.5×10^{-2} N/m. The pressure inside the buble equals at a point Z_0 below the free surface of water in a container. Taking g = 10 m/s^2, density of water = 10^3 kg/m^3, the value of Z_0 is– **[NEET 2019]**

(A) 0.5 cm (B) 100 cm

(C) 10 cm (D) 1 cm

6. A small hole of area of cross-section 2 mm^2 is present near the bottom of a fully filled open tank of heigth 2m. Taking g = 10 m/s^2, the rate of flow of water through the open hole would be nearly - **[NEET-2019]**

(A) 6.4×10^{-6} m^3/s (B) 12.6×10^{-6} m^3/s

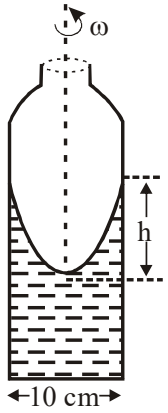
(C) 8.9×10^{-6} m^3/s (D) 2.23×10^{-6} m^3/s

7. If a soap bubble expands, the pressure inside the bubble : **[NEET 2022]**

(A) is equal to the atmospheric pressure (B) decreases

(C) increases (D) remains the same

8. A cylindrical vessel containing a liquid is rotated about its axis so that the liquid rises at its sides as shown in the figure. The radius of vessel is 5 cm and the angular speed of rotation is ω rad s^{-1}. The difference in the height, h (in cm) of liquid at the centre of vessel and at the side will be : **[JEE MAIN; 2020]**



(A) $\frac{5\omega^2}{2g}$ (B) $\frac{2\omega^2}{25g}$ (C) $\frac{25\omega^2}{2g}$ (D) $\frac{2\omega^2}{5g}$

9. A capillary tube made of glass of radius 0.15 mm is dipped vertically in a beaker filled with methylene iodide (surface tension = 0.05 Nm^{-1}, density = 667 kg m^{-3}) which rises to height h in the tube. It is observed that the two tangents drawn from liquid-glass interfaces (from op. sides of the capillary) make an angle of 60° with one another. Then h is close to (g = 10 ms^{-2}). **[JEE MAIN; 2020]**

(A) 0.087 m (B) 0.137 m (C) 0.049 m (D) 0.172 m

10. Pressure inside two soap bubbles are 1.01 and 1.02 atmosphere, respectively. The ratio of their volumes is: **[JEE MAIN; 2020]**

(A) 0.8 : 1 (B) 4 : 1 (C) 8 : 1 (D) 2 : 1

11. When a long glass capillary tube of radius 0.015 cm is dipped in a liquid, the liquid rises to a height of 15 cm within it. If the contact angle between the liquid and glass to close to 0°, the surface tension of the liquid, in milliNewton m^{-1}, is [$\rho_{(liquid)} = 900\ kg\ m^{-3}$, $g = 10\ ms^{-2}$] (Give answer in closest integer) ..... **[JEE MAIN; 2020]**

12. A air bubble of radius 1 cm in water has an upward acceleration 9.8 cm s^{-2}. The density of water is 1 gm cm^{-3} and water offers negligible drag force on the bubble. The mass of the bubble is ($g = 980\ cm/s^2$). **[JEE MAIN; 2020]**

(A) 1.52 gm (B) 4.51 gm (C) 3.15 gm (D) 4.15 gm

13. Two identical cylindrical vessels are kept on the ground and each contains the same liquid of density d. 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, 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 : **[JEE MAIN; 2020]**

(A) $\frac{1}{4}gdS(x_2 - x_1)^2$ (B) $\frac{3}{4}gdS(x_2 - x_1)^2$

(C) $gdS(x_2 + x_1)^2$ (D) $gdS(x_2^2 + x_1^2)$

14. A hollow spherical shell of outer radius R floats just submerged under the water surface. The inner radius of the shell is r. If the specific gravity of the shell material is $\frac{27}{8}$ w.r.t water, the value of r is : **[JEE MAIN; 2020]**

(A) $\frac{4}{9}R$ (B) $\frac{2}{3}R$ (C) $\frac{8}{9}R$ (D) $\frac{1}{3}R$

15. In an experiment to verify Stokes law, a small spherical ball of radius r and density ρ falls under gravity through a distance h in air before entering a tank of water. If the terminal velocity of the ball inside water is same as its velocity just before entering the water surface, then the value of h is proportional to:

(Ignore viscosity of air). **[JEE MAIN; 2020]**

(A) r^2 (B) r^4 (C) r^3 (D) r

16. A fluid is flowing through a horizontal pipe of varying cross-section, with speed υ ms^{-1} at a point where the pressure is P Pascal. At another point where pressure is $\frac{P}{2}$ pascal its speed is V ms^{-1}. If the density of the fluid is ρ kg ms^{-3} and the flow is streamline, then V is equal to : **[JEE MAIN; 2020]**

(A) $\sqrt{\frac{2P}{\rho} + \upsilon^2}$ (B) $\sqrt{\frac{P}{\rho} + \upsilon^2}$ (C) $\sqrt{\frac{P}{2\rho} + \upsilon^2}$ (D) $\sqrt{\frac{P}{\rho} + \upsilon}$

17. The terminal velocity (v_t) of the spherical rain drop depends on the radius (r) of the spherical rain drop as : **[JEE MAIN; 2022]**

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

(C) r^2 (D) r^3

18. If ρ is the density and η is coefficient of viscosity of fluid which flows with a speed *v* in the pipe of diameter d, the correct formula for Reynolds number R_e is: **[JEE MAIN; 2022]**

(A) $R_e = \frac{\eta d}{\rho v}$ (B) $R_e = \frac{\rho v}{\eta d}$

(C) $R_e = \frac{\rho v d}{\eta}$ (D) $R_e = \frac{\eta}{\rho v d}$

19. The velocity of a small ball of mass 'm' and density d_1, when dropped in a container filled with glycerine, becomes constant after some time. If the density of glycerine is d_2, then the viscous force acting on the ball, will be: **[JEE MAIN; 2022]**

(A) $mg\left(1-\frac{d_1}{d_2}\right)$ (B) $mg\left(1-\frac{d_2}{d_1}\right)$

(C) $mg\left(\frac{d_1}{d_2}-1\right)$ (D) $mg\left(\frac{d_2}{d_1}-1\right)$

20. A water drop of diameter 2 cm is broken into 64 equal droplets. The surface tension of water is 0.075 N/m. In this process the gain in surface energy will be: **[JEE MAIN; 2022]**

(A) 2.8×10^{-4} J (B) 1.5×10^{-3} J

(C) 1.9×10^{-4} J (D) 9.4×10^{-5} J

21. A water drop of radius 1 μm falls in a situation where the effect of buoyant force is negligible. Co-efficient of viscosity of air is 1.8×10^{-5} Nsm^{-2} and its density is negligible as compared to that of water 10^6 gm^{-3}. Terminal velocity of the water drop is: (Take acceleration due to gravity = 10 ms^{-2}) **[JEE MAIN; 2022]**

(A) 145.4×10^{-6} ms^{-1}

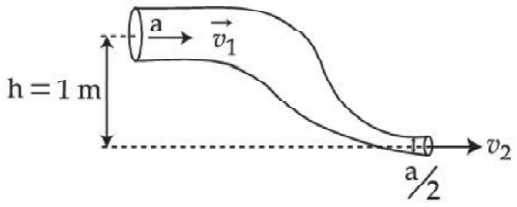
(B) 118.0×10^{-6} ms^{-1}

(C) 132.6×10^{-6} ms^{-1}

(D) 123.4×10^{-6} ms^{-1}

22. 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 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 ms^{-2})

[JEE MAIN; 2022]



23. The area of cross-section of a large tank is 0.5 m^2. It has a narrow opening near the bottom having area of cross-section 1 cm^2. A load of 25 kg is applied on the water at the top in the tank. Neglecting the speed of water in the tank, the velocity of the water, coming out of the opening at the time when the height of water level in the tank is 40 cm above the bottom, will be_____cms^{-1}. [Take g = 10 ms^{-2}] **[JEE MAIN; 2022]**

24. A liquid of density 750 kgm^{-3} flows smoothly through a horizontal pipe that tapers in cross-sectional area from A_1 = $1.2 \times 10^{-2} m^2$ to $A_2 = \frac{A_1}{2}$. The pressure difference between the wide and narrow sections of the pipe is 4500 Pa. The rate of flow of liquid is _____ $\times 10^{-3} m^3 s^{-1}$. **[JEE MAIN; 2022]**

25. A small spherical ball of radius 0.1 mm and desity 10^4 kg m^{-3} falls freely under gravity through a distace h before entering a tank of water. If, after entering the water the velocity of ball does not change and it continue to fall with same constant velocity inside water, then the value of h will be_____m :
(Given g = 10ms^{-2}, viscostiy of water= 1.0×10^{-5}N – sm^{-2}). **[JEE MAIN; 2022]**

Answer Key

EXERCISE-I

1.	A	2.	B	3.	A	4.	D	5.	D	6.	C	7.	C,D
8.	D	9.	A	10.	C	11.	C	12.	A	13.	A	14.	B
15.	C	16.	A	17.	D	18.	A	19.	B	20.	B	21.	C
22.	A	23.	A	24.	D	25.	A	26.	C	27.	A	28.	C
29.	C	30.	C	31.	C	32.	D	33.	C	34.	B	35.	D
36.	B	37.	A	38.	C								

EXERCISE-II

1. $P = \rho (gh + al)$ 2. 10 kg (98.1 N) 3. 500 kg/m^3 , 0.5
4. 248 KN/m^2
5. at P = 124.9 KN/m^2 at R = 89.5 KN/m^2 at Q = 89.5 KN/m^2 at S = 46.4KN/m^2
6. 10 cm 7. (i) 2.33 kg (ii) – 56.7 N 8. h = 2 cm
9. (a) 10 m/s (b) 2×10^{-3} m^3/s 10. 2.13 cm 11. 11 m/s
12. 10 m/s 13. 0.192 m 14. $\frac{6}{5}$ 15. $P_0 - \rho a \ell$
16. $\sqrt{2}t$ 17. $\rho V(v_1+v_2)$ 18. 2 m
19. 2h 20. 37. 5N 21. $H = \frac{11}{32\pi} m$, $h = \frac{2}{\pi}$ m
22. 32 cm/s 23. (i) $v = \left(\sqrt{2gh}\right)$ (ii) $a = \frac{2gA_1}{A_2}$
24. $\sqrt{3} : \sqrt{2}$ 25. 1.65×10^3 m 26. 0.7 N
27. A,B,C,D 28. C,D 29. B 30. A,C,D
31. A $\rightarrow$ Q ; B $\rightarrow$ R ; C $\rightarrow$ R
32. A $\rightarrow$ Q ; B $\rightarrow$ P ; C $\rightarrow$ Q
33. A $\rightarrow$ P ; B $\rightarrow$ Q ; C$\rightarrow$ Q
34. A$\rightarrow$ P ; B$\rightarrow$ P, C $\rightarrow$ R

EXERCISE-III

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

EXERCISE-IV

1.	A	2.	A	3.	D	4.	D	5.	D	6.	A	7.	B
8.	C	9.	A	10.	C	11.	101	12.	D	13.	A	14.	C
15.	B	16.	B	17.	C	18.	C	19.	B	20.	A	21.	D
22.	363	23.	300	24.	24	25.	20						