Single Correct Answer Type

1. A body floats in a liquid contained in a beaker. If the whole system falls under gravity, them the upthrust on the body due to liquids is
a) equal to the weight of the body in air
b) equal to the weight of the body in liquid
c) zero
d) equal to the weight of the immersed part of the body

2. The working of venturimeter is based on
a) Torricelli's law
b) Pascal's law
c) Bernoulli's theorem
d) Archimede's principle

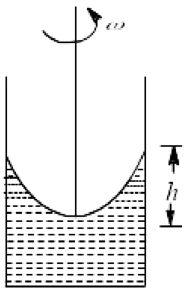
3. A rain drop of radius 1.5 mm, experiences a drag force $F=(2\times10^{-5}v)$ N, while falling through air from a height 2 km, with a velocity v. The terminal velocity of the rain drop will be nearly (use $g=10\,m\,s^{-2}$)
a) $200\,m\,s^{-1}$
b) $80\,m\,s^{-1}$
c) $7\,m\,s^{-1}$
d) $3\,m\,s^{-1}$

4. A weightless bag is filled with 5 kg of water and then weighed in water. The reading of spring balance is
a) 5 kgf
b) 2. 5 kgf
c) 1.25 kgf
d) Zero

5. A rain drop of radius 0.3 mm has a terminal velocity in air ¿ $1\,m\,s^{-1}$. The viscous force on it is
a) $101.73\times10^{-4}\,dyne$
b) $101.73\times10^{-5}\,dyne$
c) $16.95\times10^{-4}\,dyne$
d) $16.95\times10^{-5}\,dyne$

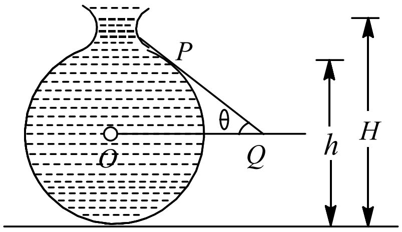
6. A rectangular vessel when full of water, takes 10 min to be emptied through an orifice in its bottom. How much time will take to be emptied when half filled with water?
a) 9 min
b) 7 min
c) 5 min
d) 3 min

7. A liquid is kept in a cylindrical vessel which is rotated along its axis. The liquid rises at the sides (figure). If the radius of the vessel is 0.05 m and the sped of rotation is $2\,rad\,s^{-1}$, find the difference in the height of the liquid at the centre of the vessel and its sides



a) 20 cm
b) 4 cm
c) 2 cm
d) 0.2 cm

8. Figure shows the vertical cross section of a vessel filled with a liquid of density ρ. The normal thrust per unit area on the walls of the vessel at point P, as shown will be



a) $h\rho g$ b) $H\rho g$ c) $(H-h)\rho g$ d) $(H-h)\rho g\cos\theta$

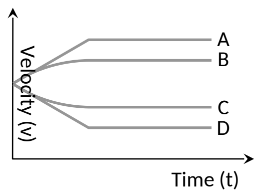
9. The density ρ of water of bulk modulus B at a depth y in the ocean is related to the density at surface ρ_0 by the relation

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

10. A large ship can float but a steel needle sinks because of

a) Viscosity b) Surface tension c) Density d) None of these

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



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

12. Two cubes each weighing 22 g exactly are taken. One is of iron $(d=8\times10^3\,kg\,m^{-3})$ and the other is of marble $(D=3\times10^3\,kg\,m^{-3})$. They are immersed in alcohol and then weighed again

a) Iron cube weighs less b) Iron cube weighs more

c) Both have equal weight d) Nothing can be said

13. A liquid is allowed into a tube of truncated cone shape. Identify the correct statement from the following.

a) The speed is high at the wider end and low at the narrow end

b) The speed is low at the wider end and high at the narrow end

c) The speed is same at both end in a streamline flow

d) The liquid flows with uniform velocity in the tube

14. An ice block contains a glass ball when the ice melts within the water containing vessel, the level of water

a) Rises b) Falls

c) Unchanged d) First rises and then falls

15. An ice berg of density $900\,kg/m^3$ is floating in water of density $1000\,kg/m^3$. The percentage of volume of ice-cube outside the water is

a) 20% b) 35% c) 10% d) 25%

16. A small spherical ball falling through a viscous medium of negligible density has terminal velocity v. Another ball of the same mass but of radius twice that of the earlier falling through the same viscous medium will have terminal velocity

a) v b) $\frac{v}{4}$ c) $\frac{v}{2}$ d) $2v$

17. The relative velocity of two consecutive layers is $8\,cm/s$. If the perpendicular distance between the layers is

$0.1\,cm$, then the velocity gradient will be

a) $8\,sec^{-1}$ b) $80\,sec^{-1}$ c) $0.8\,sec^{-1}$ d) $0.08\,sec^{-1}$

18. A block of aluminium of mass $1\,kg$ and volume $3.6\times10^{-4}\,m^3$ is suspended from a string and then completely immersed in a container of water. The decrease in tension in the string after immersion is

a) $9.8\,N$ b) $6.2\,N$ c) $3.6\,N$ d) $1.0\,N$

19. A wooden lock is taken to the bottom of a deep calm lake of water and then released. It rises up with a

a) constant acceleration b) decreasing acceleration

c) constant velocity d) decreasing velocity

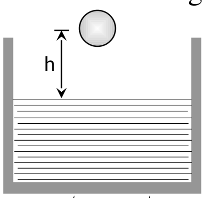
20. If the work done in blowing a bubble of volume V is W, then the work done in blowing a soap bubble of volume $2V$ will be

a) W b) $2W$ c) $\sqrt{2}W$ d) $4^{1/3}W$

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

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

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

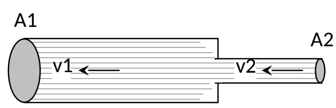


a) $\frac{2}{9}r^2\left(\frac{1-\rho}{\eta}\right)g$ b) $\frac{2}{81}r^2\left(\frac{\rho-1}{\eta}\right)g$ c) $\frac{2}{81}r^4\left(\frac{\rho-1}{\eta}\right)^2g$ d) $\frac{2}{9}r^4\left(\frac{\rho-1}{\eta}\right)^2g$

23. A solid of density D is floating in a liquid of density$d$. If v is the volume of solid submerged in the liquid and V is the total volume of the solid, then v/V is equal to

a) $\frac{d}{P}$ b) $\frac{D}{d}$ c) $\frac{D}{(D+d)}$ d) $\frac{D+d}{D}$

24. A liquid flows in a tube from left to right as shown in figure A_1 and A_2 are the cross-sections of the portions of the tube as shown. Then the ratio of speeds v_1/v_2 will be



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

25. From a steel wire of density ρ is suspended a brass block of densityρ_B. The extension of steel wire comes to l. If the brass block is now fully immersed in a liquid of density ρ_L, the extension becomes l'. The ratio l/l' will be

a) $\frac{\rho_B-\rho}{\rho_L-\rho}$ b) $\frac{\rho_L}{\rho_B-\rho_L}$ c) $\frac{\rho_B-\rho_L}{\rho_B}$ d) $\frac{\rho_B}{\rho_B-\rho_L}$

26. The excess pressure inside a spherical drop of radius r of a liquid of surface tension T is

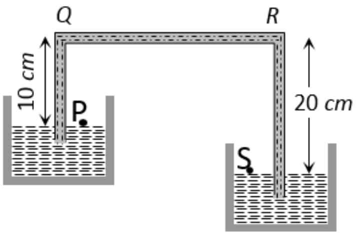
a) Directly proportional to r and inversely proportional to T

b) Directly proportional to T and inversely proportional to r

c) Directly proportional to the product of T and r

d) Inversely proportional to the product of T and r

27. A siphon in use is demonstrated in the following figure. The density of the liquid flowing in siphon is $1.5\, gm/cc$. The pressure difference between the point P and S will be



a) $10^5\, N/m$

b) $2\times10^5\, N/m$

c) Zero

d) Infinity

28. A hole in the bottom of the tank having water. If total pressure at bottom is 3 atm ($1\, atm = 10^5\, N\, m^{-2}$), then velocity of water flowing from hole is

a) $\sqrt{400}\, m\, s^{-1}$ b) $\sqrt{600}\, m\, s^{-1}$ c) $\sqrt{60}\, m\, s^{-1}$ d) None of these

29. A large tank filled with water to a height h is to be emptied through a small hole at the bottom. The ratio of times taken for the level of water to fall from h ¿ $h/2 \wedge h/2$ ¿ $zero\ is$

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

30. A block of steel of size $5\, cm \times 5\, cm \times 5\, cm$ is weighed in water. If the relative density of steel is 7, its apparent weight is

a) $6\times5\times5\times5\, gf$ b) $4\times4\times4\times7\, gf$ c) $5\times5\times5\times7\, gf$ d) $4\times4\times4\times6\, gf$

31. There are two holes one each along the opposite sides of a wide rectangular tank. The cross-section of each hole is $0.01 m^2$ and the vertical distance between the holes is one meter. The tank is filled with water flows out of the holes is (density of water¿ $1000\, kg\, m^{-3}$ ¿

a) 100 b) 200 c) 300 d) 400

32. Water in river 20 m deep is flowing at a speed of $10\, ms^{-1}$. The shearing stress between the horizontal layers of water in the river in $N\, m^{-2}$ is (coefficient of viscosity of water¿ 10^{-3} SI units)

a) $1\times10^{-2}\, Nm^{-2}$ b) $0.5\times10^{-2}\, Nm^{-2}$ c) $1\times10^{-3}\, Nm^{-2}$ d) $0.5\times10^{-3}\, Nm^{-2}$

33. Ice pieces are floating in beaker A containing water also in a beaker B containing miscible liquid of specific gravity 1.2. When ice melts, the level of

a) water increases in A b) water decreases in A

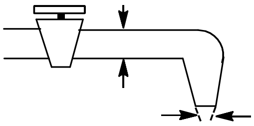
c) liquid in B decreases d) liquid in B increases

34. On the surface of the liquid in equilibrium, molecules of the liquid possess

a) maximum potential energy b) maximum potential energy

c) maximum kinetic energy d) minimum kinetic energy

35. Water flowing out of the mouth of a tap and falling vertically in streamline flow forms a tapering column, *ie* the area of cross-section of the liquid column decreases as it moves down. Which of the following is the most accurate explanation for this?



a) Falling water tries to reach a terminal velocity and hence, reduces the area of cross-section to balance upward and downward forces
b) As the water moves down, its speed increases and hence, its pressure decreases. It is then compressed by atmosphere
c) The surface tension causes the exposed surface area of the liquid to decrease continuously
d) The mass of water flowing out per second through any cross-section must remain constant. As the water is almost incompressible, so the volume of water flowing out per second must remain constant. As this is equal to velocity × area, the area decreases as velocity increases

36. Speed of 2 cm radius ball in a viscous liquid is $20\, cm\, s^{-1}$. Then the speed of 1 cm radius ball in the same liquid is

a) $5\, cm\, s^{-1}$ b) $10\, cm\, s^{-1}$ c) $40\, cm\, s^{-1}$ d) $80\, cm\, s^{-1}$

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

a) $\frac{d_0}{d}$ b) $\frac{d d_0}{d+d_0}$ c) $\frac{d-d_0}{d}$ d) $\frac{d d_0}{d-d_0}$

38. A piece of ice is floating in a jar containing water. When the ice melts, then the level of water

a) rises b) Falls c) remains unchanged d) rises or falls

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

a) Increases b) Decreases c) Remains unchanged d) None of these

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

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

41. Water rises in a capillary tube to a height h. Choose false statement regarding capillary rise from the following.

a) On the surface of Jupiter, height will be less than h
b) In a lift moving up with constant acceleration height is less than h
c) On the surface of moon the height is more than h
d) In a lift moving down with constant acceleration height is less than h

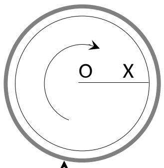
42. Water is in streamline flow along a horizontal pipe with nonuniform cross-section. At a point in the pipe where the area of cross-section is $10\, cm^2$, the velocity of water is $1\, m\, s^{-1}$ and the pressure is 2000 Pa. The pressure at another point where the cross-sectional area is $5\, cm^2$ is

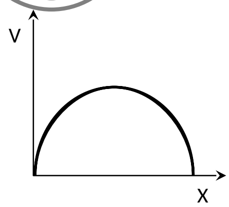
a) 4000 Pa b) 2000 Pa c) 1000 Pa d) 500 Pa

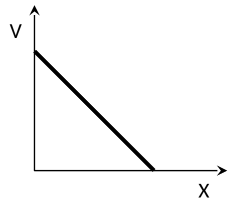
43. An iron sphere of mass 20×10^{-3}kg falls through a viscous liquid with terminal velocity $0.5\, ms^{-1}$. The terminal velocity $(¿ms^{-1})$ of another iron sphere of mass54×10^{-2} kg is

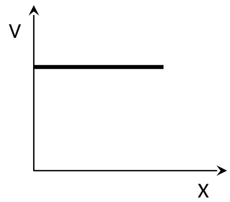
a) 4.5 b) 3.5 c) 2.5 d) 1.5

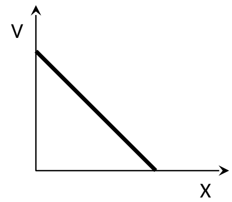
44. The diagram shows a cup of tea seen from above. The tea has been stirred and is now rotating without turbulence. A graph showing the speed v with which the liquid is crossing points at a distance X from O along a radius XO would look like



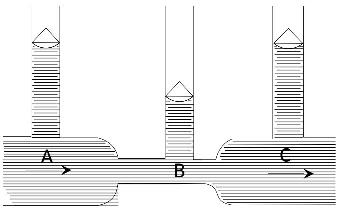
a) 

b) 

c) 

d) 

45. In the following fig. is shown the flow of liquid through a horizontal pipe. Three tubes A, B and C are connected to the pipe. The radii of the tubes A, B and C at the junction are respectively $2\,cm$, $1\,cm$ and $2\,cm$. It can be said that the



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

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

c) Height of the liquid in all the three tubes is the same

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

46. If the length of tube is less and cannot accommodate the maximum rise of liquid then

a) liquid will form fountain
b) liquid will not rise
c) the meniscus will adjust itself so that the water does not spill
d) none of the above

47. What is the ratio of surface energy of 1 small drop and 1 large drop if 1000 drops combined to form 1 large drop?

a) 100 : 1
b) 1000 : 1
c) 10 : 1
d) 1 : 100

48. Determine the energy stored in the surface of a soap bubble of radius 2.1 cm if its surface tension is $4.5 \times 10^{-2}\,Nm^{-1}$.

a) 8 mJ
b) 2.46 mJ
c) $4.93 \times 10^{-4}\,J$
d) None of these

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

a) $9.4\,m$
b) $4.9\,m$
c) $0.49\,m$
d) $0.94\,m$

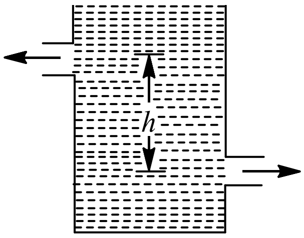
50. A raindrop with radius $1.5\,mm$ falls from a cloud at a height $1200\,m$ from ground. The density of water is $1000\,kg/m^3$ and density of air is $1.2\,kg/m^3$. Assume the drop was spherical throughout the fall and there is no air drag. The impact speed of the drop will be

a) $27\,km/h$
b) $550\,km/h$
c) Zero
d) $129\,km/h$

51. A piece of wax weighs 18.03 g in air. A piece of metal is found to weigh 17.03 g in water. It is tied to the wax and both together weigh 15.23 g in water. Then, the specific gravity of wax id

a) $\frac{18.03}{17.03}$
b) $\frac{17.03}{18.03}$
c) $\frac{18.03}{19.83}$
d) $\frac{15.03}{17.03}$

52. There are two identical small holes on the opposite sides of a tank containing a liquid. The tank is open at the top. The difference in height between the two holes is h. As the liquid comes out of the two holes, the tank will experience a net horizontal force proportional to



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

53. If two soap bubble of different radii are connected by a tube

a) Air flows from the bigger bubble to the smaller bubble till the sizes become equal

b) Air flows from bigger bubble to the smaller bubble till the sizes are interchanged

c) Air flows from the smaller bubble to the bigger

d) There is no flow of air

54. The surface tension of soap solution is $0.03\ Nm^{-1}$. the work done in blowing to from a soap bubble of surface area $40\ cm^2, (¿J), is$

a) 1.2×10^{-4}　　b) 2.4×10^{-4}　　c) 12×10^{-4}　　d) 24×10^{-4}

55. A sniper fires a rifle bullet into a gasoline tank making a hole $53.0\ m$ below the surface of gasoline. The tank was sealed at $3.10\ atm$. The stored gasoline has a density of $660\ kg\ m^{-3}$. The velocity with which gasoline begins to shoot out of the hole is

a) $27.8\ m\ s^{-1}$　　b) $41.0\ m\ s^{-1}$　　c) $9.6\ m\ s^{-1}$　　d) $19.7\ m\ s^{-1}$

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

a) + 10%　　b) + 46%　　c) -10%　　d) -40%

57. When a pinch of salt or any other salt which is soluble in water is added to water, its surface tension

a) Increases　　b) Decreases

c) May increase or decrease depending upon salt　　d) None of the above

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

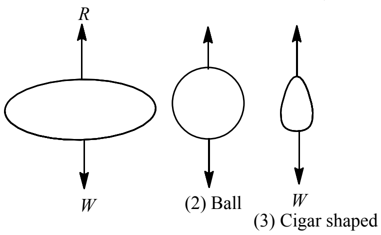
a) Both pieces must have equal weights　　b) Both pieces must have equal densities

c) Both pieces must have equal volumes　　d) Both are floating to the same depth

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

a) $V/2$　　b) $V/3$　　c) $V/4$　　d) V

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



a) 1<2<3　　b) 2<3<1　　c) 3<2<1　　d) 3<1<2

61. A boat carrying a number of large stones is floating in a water tank. What would happen to the water level, if a few stones are unloaded into water?

a) Rises

b) Falls

c) Remains unchanged

d) Rises till half the number of stones are unloaded and the begins to fall

62. A glass flask having mass 390 g and an interior volume of $500\,cm^3$ floats on water when it is less than half filled with water. The density of the material of the flask is

a) $0.8\,g\,cc^{-1}$ b) $2.8\,g\,cc^{-1}$ c) $1.8\,g\,cc^{-1}$ d) $0.28\,g\,cc^{-1}$

63. A liquid flows through a pipe of non-uniform cross-section. If A_1 and A_2 are the cross-sectional area of the pipe at two points, the ratio of velocities of the liquid at these points will be

a) $A_1 A_2$ b) $\frac{A_1}{A_2}$ c) $\frac{A_2}{A_1}$ d) $\frac{1}{A_1 A_2}$

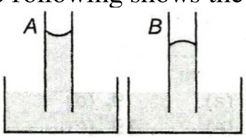
64. A block of ice floats on a liquid of density 1.2 in a beaker then level of liquid when ice completely melt

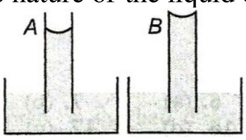
a) Remains same b) Rises c) Lowers d) (a), (b) or (c)

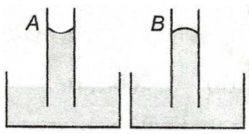
65. Eight drops of a density ρ and each of radius a are falling through air with a constant velocity $375\,cm\,s^{-1}$. When the eight drops coalesce to from a single drop the terminal velocity of the new drop will be

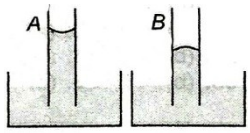
a) $1.5 \times 10^{-2} ms^{-1}$ b) $2.4 \times 10^{-2} ms^{-1}$ c) $0.75 \times 10^{-2} ms^{-1}$ d) $15 \times 10^{-2} ms^{-1}$

66. A capillary tube (A) is dipped in water. Another identical tube (B) is dipped in a soap-water solution. Which of the following shows the relative nature of the liquid columns in the two tubes ?

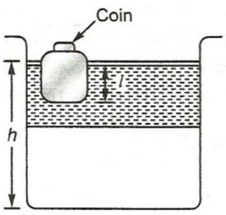
a) 

b) 

c) 

d) 

67. A wooden black, with a coin placed on its top, flats in water as shown in the figure. The distance $h \wedge l$are shown there. After sometime, the coin falls into the water, then



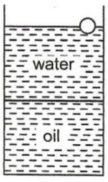
a) $both\, l \wedge h\, increace$

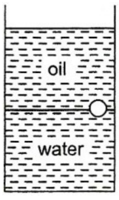
b) $both\, l \wedge h\, decrese$

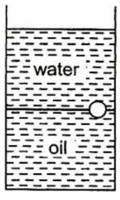
c) l decrease and h increase

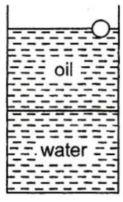
d) $l\, increase \wedge h\, decrease$

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

a) 

b) 

c) 

d) 

69. A drop of water breaks into two droplets of equal size. In this process, which of the following statements is

correct?

a) The sum of the temperature of the two droplets together is equal to temperature of the original drop

b) The sum of the masses of the two droplets is equal to mass of drop

c) The sum of the radii of the two droplets is equal to the radius of the drop

d) The sum of the surface areas of the two droplets is equal to the surface area of the original drop

70. A open U-tube contains mercury. When 11.2 cm of water is poured into one of the arms of the tube, how high dose the mercury rise in the other arm from its initial unit?

a) $0.56\,cm$ b) $1.35\,cm$ c) $0.41\,cm$ d) $2.32\,cm$

71. At what speed, the velocity head of water is equal to pressure head of 40 cm of Hg?

a) $10.3\,ms^{-1}$ b) $2.8\,ms^{-1}$ c) $5.6\,ms^{-1}$ d) $8.4\,ms^{-1}$

72. A soap bubble in air (two surface) has surface tension $0.03\,Nm^{-1}$. Find the gauge pressure inside a bubble of diameter 30 mm.

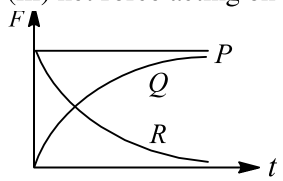
a) 2 Pa b) 4 Pa c) 16 Pa d) 8 Pa

73. A spherical ball is dropped in a long column of viscous liquid. Which of the following graphs represent the variation of

(i)gravitational force with time

(ii) viscous force with time

(iii) net force acting on the ball with time?



a) Q,R,P b) R,Q,P c) P,Q,R d) R,P,Q

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

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

75. A manometer connected to a close tap reads $3.5\times10^5\,Nm^{-2}$. When the valve is opened, the reading of manometer falls to$3.0\times10^5\,Nm^{-2}$, then velocity of flow of water is

a) $100\,ms^{-1}$ b) $10\,ms^{-1}$ c) $1\,ms^{-1}$ d) $10\sqrt{10}\,ms^{-1}$

76. A wooden ball of density D is immersed in water of density d to a depth h below the surface of water and then released. Upto what height will then ball jump out of water?

a) $\frac{d}{D}h$ b) $\left(\frac{d}{D}-1\right)h$ c) h d) Zero

77. The rate of flow of liquid through a capillary tube of radius r is V when the pressure difference across the two ends of the capillary is p. If pressure is increased by 3 p and radius is reduced to $r/2$, then the rate of flow becomes

a) $V/9$ b) $3V/8$ c) $V/4$ d) $V/3$

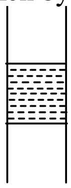
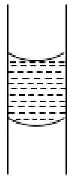
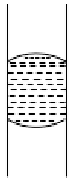
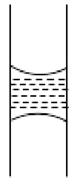
78. A glass tube 80 cm long and open at both ends is half immersed in mercury. Then the top of the tube is closed and it is taken out of the mercury. A column of mercury 20 cm long then remains in the tube. The atmospheric pressure (in cm of Hg) is

a) 90 b) 75 c) 60 d) 45

79. A metallic sphere of mass M falls through glycerine with a terminal velocity v. If we drop a ball of mass $8M$ of same metal into a column of glycerine, the terminal velocity of the ball will be

a) $2v$ b) $4v$ c) $8v$ d) $16v$

80. A vertical glass capillary tube, open at both ends, contains some water. Which of the following shapes may be taken by the water in the tube?

a)  b)  c)  d) 

81. Two drops of the same radius are falling through air with a steady velocity of $5\,cm$ per sec. If the two drops coalesce, the terminal velocity would be

a) $10\,cm$ per sec b) $2.5\,cm$ per sec c) $5\times(4)^{1/3}\,cm$ per sec d) $5\times\sqrt{2}\,cm$ per sec

82. In a streamline flow if the gravitational head is h. The kinetic and pressure heads are

a) v^2/g and p/ρ b) $v^2/2g$ and p/ρ g c) $v^2/2g$ and p/ρ d) $v^2/2$ and p/ρ g

83. Two soap bubbles A and B are formed at the two open ends of a tube. The bubble A is smaller than bubble B. Valve and air can flow freely between the bubbles, then

a) There is no change in the size of the bubbles

b) The two bubbles will become of equal size

c) A will become smaller and B will become larger

d) B will become smaller and A will become larger

84. Water is moving with a speed of $5.18\,ms^{-1}$ through a pipe with a cross-sectional area of $4.20\,cm^2$. The water gradually descend 9.66 m as the pipe increase in area to $7.60\,cm^2$. The speed of flow at the lower level is

a) $3.0\,ms^{-1}$ b) $5.7\,ms^{-1}$ c) $3.82\,ms^{-1}$ d) $2.86\,ms^{-1}$

85. The velocity of the surface layer of water in a river of depth $10\,m$ is 5 $m\,s^{-1}$. The shearing stress between the surface layer and the bottom layer is (Coefficient of viscosity of water, $\eta=10^{-3}$ SI units)

a) $0.6\times10^{-3}\,N\,m^{-2}$ b) $0.8\times10^{-3}\,N\,m^{-2}$ c) $0.5\times10^{-3}\,N\,m^{-2}$ d) $10^{-3}\,N\,m^{-2}$

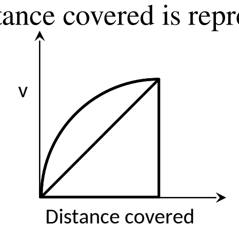
86. A wooden piece can float both in mercury (of density $13.6\,gm/cc$) and in water (of density $1\,gm/cc$). The ratio of mass of mercury displaced to the mass of water displaced is

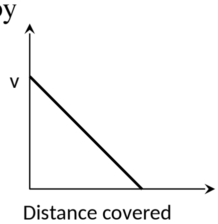
a) 1 b) 13.6 c) $\frac{1}{13.6}$ d) $\frac{12.6}{13.6}$

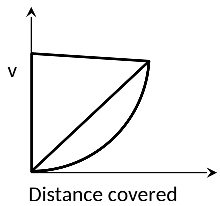
87. An adulterated sample of milk has density of $1032\,kg\,m^{-3}$, while pure milk has a density of $1080\,kg\,m^{-3}$. Then the volume of pure milk in a sample of 10 L of adulterated milk is

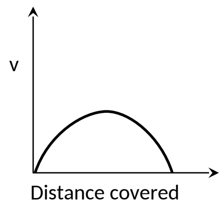
a) 0.5 L b) 1.0 L c) 2.0 L d) 4.0 L

88. A lead shot of $1\,mm$ diameter falls through a long column of glycerine. The variation of its velocity v. with distance covered is represented by

a) 

b) 

c) 

d) 

89. The rate of flow of liquid through an orifice of a tank does not depend upon

a) the size of orifice b) density of liquid

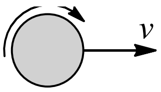
c) the height of fluid column d) acceleration due to gravity

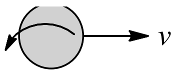
90. A beaker containing water is balance on the pan of a common balance. A solid of specific gravity 1 and mass 5 g

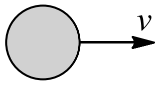
is tied to the arm of the balance and immersed in water contained in the beaker. The scale pan with the beaker

a) Goes down b) Goes up c) Remains unchanged d) None of these

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

a) 

b) 

c) 

d) None of these

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

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

93. By sucking through a straw, a student can reduce the pressure in his lungs to 750 mm of Hg (density ¿ $13.6\, g\, cm^{-3}$ ¿. Using the straw, he can drink water from a glass upto a maximum depth of

a) 10 cm b) 75 cm c) 13.6 cm d) 1.36 cm

94. A hemispherical bowl just floats without sinking in a liquid of density $1.2 \times 10^3\, kg\, m^{-3}$. If outer diameter and the density of the bowl are 1 m and $2 \times 10^4\, kg\, m^{-3}$ respectively, then the inner diameter of the bowl will be

a) 0.94 m b) 0.96 m c) 0.98 m d) 0.99 m

95. A vessel contains oil (density $0.8\, gc\, c^{-1}$) over mercury (density $13.6\, gc\, c^{-1}$). A homogeneous sphere floats with half its volume immersed in mercury and the other half in oil. The density of the material of the sphere in $gc\, c^{-1}$ is

a) 3 b) 6.4 c) 7.2 d) 12.8

96. Bernoulli's principle is not involved in the working/explanation of

a) Movement of spinning ball b) Carburetor of automobile

c) Blades of a kitchen mixer d) Heart attack

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

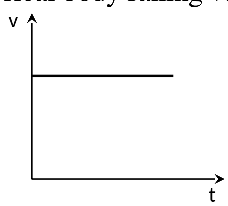
a) $350\, c\, m^3$ b) $300\, c\, m^3$ c) $250\, c\, m^3$ d) $22\, c\, m^3$

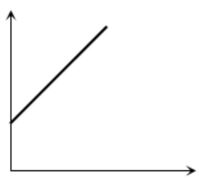
98. Surface tension vanishes at

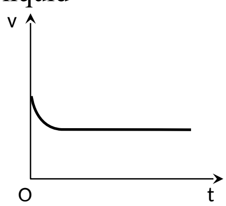
a) absolute zero temperature b) transition temperature

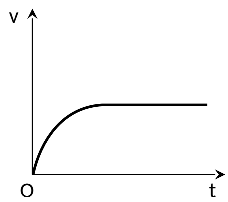
c) critical temperature d) None of the above

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

a) 

b) 

c) 

d) 

100. If the excess pressure inside a soap bubble is balanced by oil column of height 2 mm, then the surface tension of soap solution will be ¿

a) $3.9\, Nm^{-1}$ b) $3.9 \times 10^{-1}\, Nm^{-1}$ c) $3.9 \times 10^{-2}\, Nm^{-1}$ d) $3.9\, dyne\, m^{-1}$

101. For flow of a liquid to be streamline, the following condition (s) apply

a) Fluid should have high viscosity b) Critical velocity should be large

c) Diameter of the tube should be small
d) All of the above

102. A piece of solid weighs 120 g in air, 80 g in water and 60 g in a liquid. The relative density of the solid and that of the liquid are respectively

a) 3,2
b) $2,\frac{3}{4}$
c) $\frac{3}{2},2$
d) 4,3

103. A hydraulic lift is designed to life cars of maximum mass of 3000 kg. The area of cross-section of the piston carrying the load is $4.25\times10^{-12}m^2$. What maximum pressure the smaller piston have to bear?

a) $6.92\times10^{5}\,N\,m^{-2}$
b) $7.82\times10^{7}\,N\,m^{-2}$
c) $9.63\times10^{9}\,N\,m^{-2}$
d) $13.76\times10^{11}\,N\,m^{-2}$

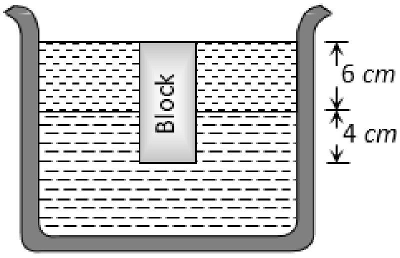
104. Surface tension of a liquid is due to

a) Gravitational force between molecules
b) Electrical force between molecules
c) Adhesive force between molecules
d) Cohesive force between molecules

105. When water flows at a rate Q through a tube of radius r placed horizontally, a pressure difference p develops across the ends of the tube. If the radius of the tube is doubled and the rate of flow halved, the pressure difference will be

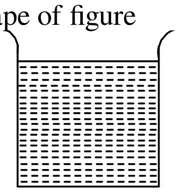
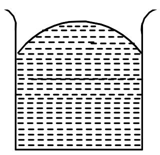
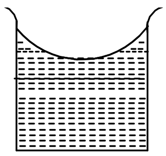
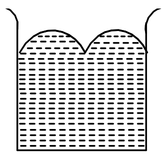
a) $8\,p$
b) p
c) $p/8$
d) $p/32$

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



a) $706\,g$
b) $607\,g$
c) $760\,g$
d) $670\,g$

107. If a liquid is placed in a vertical cylindrical vessel and the vessel is rotated about its axis, the liquid will take the shape of figure

a) 
b) 
c) 
d) 

108. An object of weight w and density ρ is submerged in a fluid of density ρ_1. Its apparent weight will be

a) $w(\rho-\rho_1)$
b) $(\rho-\rho_1)/w$
c) $w\left(1-\frac{\rho_1}{\rho}\right)$
d) $w(\rho_1-\rho)$

109. An engine pumps water continuously through a hose. Water leaves the hose with a velocity v and m is the mass per unit length of the water jet. What is the rate at which kinetic energy is imparted to water

a) $\frac{1}{2}mv^3$
b) mv^3
c) $\frac{1}{2}mv^2$
d) $\frac{1}{2}m^2v^2$

110. The density of ice is $0.9\,g\,cc^{-1}$ and that of sea water is $1.1\,g\,cc^{-1}$. An ice berg of volume V is floating in sea water. The fraction of ice berg above water level is

a) 1/11
b) 2/11
c) 3/11
d) 4/11

111. A cylindrical tank has a hole of $1\,cm^2$ in its bottom. If the water is allowed to flow into the tank from a tube above it at the rate of $70\,cm^3/sec$. then the maximum height up to which water can rise in the tank is

a) $2.5\,cm$
b) $5\,cm$
c) $10\,cm$
d) $0.25\,cm$

112. A balloon of volume $1500\,m^3$ and weighing 1650 kg with all its equipment is filled with He (density $0.2\,kg\,m^{-3}$). If the density of air be $1.3\,kg\,m^{-3}$, the pull on the rope tied to the balloon will be

a) 300 kg b) 1950 kg c) 1650 kg d) Zero

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

a) P b) $\frac{3P}{4}$ c) $\frac{P}{2}$ d) $\frac{P}{4}$

114. Water falls from a tap , down the streamline

a) Area decreases

b) Area increases

c) Velocity remains same

d) Area remains same

115. What is the radius of the biggest aluminium coin of thickness t and density ρ, which will still be able to float on the water surface of surface tension S?

a) $\frac{4S}{3\rho gt}$ b) $\frac{3S}{4\rho gt}$ c) $\frac{2S}{\rho gt}$ d) $\frac{S}{\rho gt}$

116. A square wire frame of size L is dipped in a liquid. On taking out a membrane is formed. If the surface tension of liquid is T, then the force acting on a frame will be

a) $2T/L$ b) $4T/L$ c) $8T/L$ d) $16T/L$

117. A tank is filled with water of density $1\,g\,cm^{-3}$ and oil of density $0.9\,g\,cm^{-3}$. The height of water layer is 100 cm and of oil layer is 400 cm. If $g=980\,cm\,s^{-2}$, then the velocity of efflux from an opening in the bottom of the tank is

a) $\sqrt{900\times980}\,cms^{-1}$ b) $\sqrt{1000\times980}\,cms^{-1}$ c) $\sqrt{920\times980}\,cms^{-1}$ d) $\sqrt{950\times980}\,cms^{-1}$

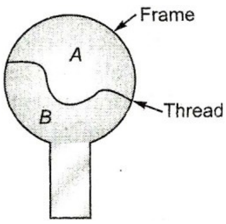
118. A 20 cm long capillary tube is dipped in water. The water rises upto 8 cm. If the entire arrangement is put in a freely falling elevator, the length of water column in the capillary tube will be

a) 8 cm b) 10 cm c) 4 cm d) 20 cm

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

a) $\frac{1}{2}\sqrt{\frac{\sigma}{\rho}}$ b) $\frac{1}{2}\frac{\sigma}{\rho}$ c) $\sqrt{\frac{\rho}{\sigma}}$ d) $\sqrt{\frac{\sigma}{\rho}}$

120. A thread is tied slightly loose to a wire frame as in figure and the frame is dipped into a soap solution and taken out. The frame is completely covered with the film. When the portion A is punctured with a pin, the thread



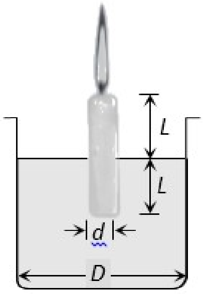
a) Becomes concave towards A

b) Becomes convex towards A

c) Either (a) or (b) depending on the size of A with respect to B

d) Remain in the initial position

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

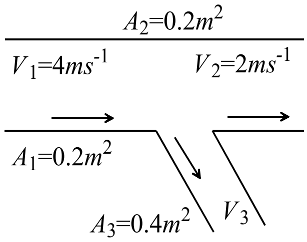


a) Remain at the same height
b) Fall at the rate of $1\,cm/hour$
c) Fall at the rate of $2\,cm/hour$
d) Go up the rate of $1\,cm/hour$

122. A drop of liquid of diameter 2.8 mm breaks up into 125 identical drops. The change in energy is nearly $(S=75\,dyne\,cm^{-1})$
a) Zero
b) 19 erg
c) 46 erg
d) 74 erg

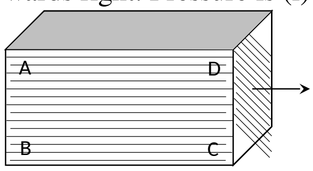
123. There is a hole of area A at the bottom of a cylindrical vessel. Water is filled upto a height h and water flows out in t sec. If water is filled to a height $4h$, then it will flow out in time
a) $2t$
b) $4t$
c) $16t$
d) $7/4t$

124. In the figure, the velocity V_3 will be



a) Zero
b) $4\,m\,s^{-1}$
c) $1\,m\,s^{-1}$
d) $3\,m\,s^{-1}$

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



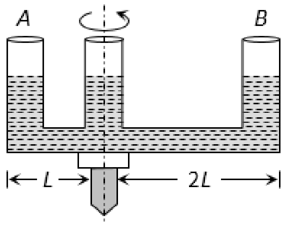
a) (i) B (ii) D
b) (i) C (ii) D
c) (i) B (ii) C
d) (i) B (ii) A

126. Two substances of densities ρ_1 and ρ_2 are mixed in equal volume and the relative density of mixture is 4. When they are mixed in equal masses, the relative density of the mixture is 3. The values of ρ_1 and ρ_2 are
a) $\rho_1=6$ and $\rho_2=2$
b) $\rho_1=3$ and $\rho_2=5$
c) $\rho_1=12$ and $\rho_2=4$
d) None of these

127. A beaker of radius 15 cm is filled with a liquid of surface tension $0.75\,Nm^{-1}$. Force across an imaginary diameter on the surface of the liquid is
a) 0.075 N
b) $1.5\times10^{-2}N$
c) 0.225 N
d) $2.25\times10^{-2}N$

128. A parrot sitting on the floor of a wire cage which is being carried by a boy, starts flying. The boy will feel that the cage is now
a) Heavier
b) Lighter
c) Shows no change in weight
d) Lighter in the beginning and heavier later

129. 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

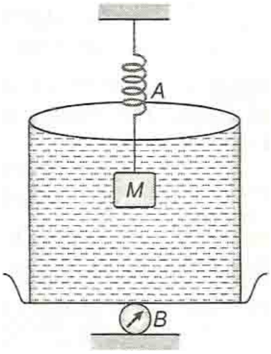
c) Water level in Section A comes down and that in B it goes up

d) Water levels remains same in both section

130. A liquid does not wet the solid surface if the angle of contact is

a) Zero　b) equal to 45°　c) equal to 90°　d) greater than 90°

131. The spring balance A reads 2 kg with a block of mass 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 a beaker as shown in figure



a) The balance A will read more than 2 kg

b) The balance B will read less than 5 kg

c) The balance A will read less than 2 kg and B will read more than 5 kg

d) The balance A will read more than 2 kg and B will read less than 5 kg

132. The surface area of air bubble increases four times when it rises from bottom to top of a water tank where the temperature is uniform. If the atmospheric pressure is 10 m of water, the depth of the water in the tank is

a) 30 m　b) 40 m　c) 70 m　d) 80 m

133. A vessel, whose bottom has round holes with diameter 0.1 mm is filled with water. The maximum height upto which water can be filled without leakage is (Surface tension = $75\, dyne\, cm^{-1}$ and $g = 1000\, cm s^{-2}$)

a) 100 cm　b) 75 cm　c) 60 cm　d) 30 cm

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

a) 4 : 9　b) 9 : 4　c) 8 : 27　d) 1 : 1

135. A ball whose density is $0.4 \times 10^3\, kg\, m^{-3}$ falls into water from a height of 9 cm. To what depth does the ball sink?

a) 9 cm　b) 6 cm　c) 4.5 cm　d) 2.25 cm

136. The viscous force acting on a rain drop of radius 0.35 mm falling through air with a velocity of $1\, ms^{-1}$, is $(\eta = 2 \times 10^{-4}\, N\, s\, m^{-2})$

a) $6.6 \times 10^{-6} N$　b) $6.6 \times 10^{-5} N$　c) $1.32 \times 10^{-7} N$　d) $13.2 \times 10^{-7} N$

137. Two bodies are in equilibrium when suspended in water from the arms of a balance. The mass of one body is $36\,g$ and its density $9\,g/cm^3$. If the mass of the other is $48\,g$, its density in g/cm^3 is

a) $\frac{4}{3}$ b) $\frac{3}{2}$ c) 3 d) 5

138. Consider an iceberg floating in sea water. The density of sea water is $1.03\,g\,cc^{-1}$ and that ice is $0.92\,g\,cc^{-1}$ The fraction of total volume of iceberg above the level of sea water is nearby

a) 1.8% b) 3% c) 8% d) 11%

139. A piece of wood if floating in water. When the temperature of water rises, the apparent weight of the wood will

a) Increase b) Decrease

c) may increase or decrease d) remain same

140. If the rise in height of capillary of two tubes are 6.6 cm and 2.2 cm, then the ratio of the radii of tubes is

a) 1:3 b) 3:1 c) 1:2 d) 1:6

141. A piston of cross-section area $100\,cm^2$ is used in a hydraulic press to exert a force of 10^7 dynes on the water. The cross-sectional area of the other piston which supports an object having a mass $2000\,kg$. is

a) $100\,cm^2$ b) $10^9\,cm^2$ c) $2\times10^4\,cm^2$ d) $2\times10^{10}\,cm^2$

142. A water film is made between two straight parallel wires of length 10 cm separated by 5 mm from each other. If the distance between the wires is increased by 2 mm. How much work will be done? Surface tension for water is $72\,dyne\,cm^{-1}$

a) 288 erg b) 72 erg c) 144 erg d) 216 erg

143. A thin uniform cylindrical shell, closed at both ends, is partially filled with water. It is floating vertically in water in half-submerged state. If ρ_c is the relative density of the material of the shell with respect to water, then the correct statement is that the shell is

a) More than half filled if ρ_c is less then 0.5 b) More than half filled if ρ_c is less then 1.0

c) Half filled if ρ_c is less then 0.5 d) Less than half filled if ρ_c is less then 0.5

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

a) It will slowly come back to its earlier position b) It will remain submerged, where it is left

c) It will sink d) It will come out violently

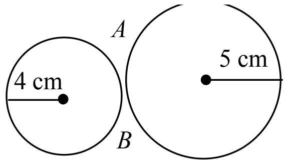
145. A cylinder of height 20 m is completely filled with water. The velocity of efflux of water (in ms^{-1}) through a hole on the side wall of the cylinder near its bottom, is

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

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

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

147. Two soap bubbles of radii r_1 and r_2 equal to 4 cm and 5 cm respectively are touching each other over a common surface AB (shown in figure). Its radius will be



a) 4 cm b) 4.5 cm c) 5 cm d) 20 cm

148. When a glass capillary tube of radius 0.015 cm is dipped in water, the water rises to height of 15 cm within it. Assuming contact angle between water and glass to be $0°$, the surface tension of water is $[\rho_{water}=1000\,kg\,m^{-3}, g=9.81\,ms^{-2}]$

a) $0.11\,Nm^{-1}$ b) $0.7\,Nm^{-1}$ c) $0.072\,Nm^{-1}$ d) None of these

149. Angle of contact of a liquid with a solid depend on

a) solid only b) liquid only

c) both on solid and liquid d) orientation of the solid surface in liquid

150. If the atmospheric pressure is P_a, then the pressure P at depth h below the surface of a liquid of density ρ open to the atmosphere is

a) $P_a - \frac{\rho g h}{2}$ b) $P_a - \rho g h$ c) P_a d) $P_a + \rho g h$

151. If a drop of water is broken in to smaller drops the surface energy

a) Increases b) Decreases

c) Remains unchanged d) Can increases as well as decreases

152. Two spherical soap bubbles of radii r_1 and r_2 in vacuum combine under isothermal conditions. The resulting bubble has radius equal to

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

153. Water flows through a vertical tube of variable cross-section. The area of cross-section at A and B are 6 and 3 mm^2 respectively. If 12 cc of water enters per second through A, find the pressure difference $p_A - p_B (g=10\,m\,s^{-2})$ The separation between cross-section at A and B is 100 cm

a) $1.6\times10^5\,dyne\,cm^{-2}$ b) $2.29\times10^5\,dyne\,cm^{-2}$ c) $5.9\times10^5\,dyne\,cm^{-2}$ d) $3.9\times10^5\,dyne\,cm^{-2}$

154. A small spherical ball of steel falls through a viscous medium with terminal velocity v. If a ball of twice the radius of the first one but of the same mass is dropped through the same method, it will fall with a terminal velocity (neglect buoyancy)

a) $\frac{v}{2}$ b) $\frac{v}{\sqrt{2}}$ c) v d) $2v$

155. A body of density ρ is dropped from rest at a height h into a lake of density σ, where $\sigma > \rho$. Neglecting all dissipative forces, calculate the maximum depth to which the body sinks before returning to float on the surface

a) $\frac{h}{\sigma-\rho}$ b) $\frac{h\rho}{\sigma}$ c) $\frac{h\rho}{\sigma-\rho}$ d) $\frac{h\sigma}{\sigma-\rho}$

156. One drop of soap bubble of diameter D breaks into 27 drops having surface tension . The change in surface energy is

a) $2\pi TD^2$ b) $4\pi TD^2$ c) πTD^2 d) $8\pi TD^2$

157. For a ball falling in a liquid with constant velocity, ratio of the resistance force due to the liquid to that due to gravity is

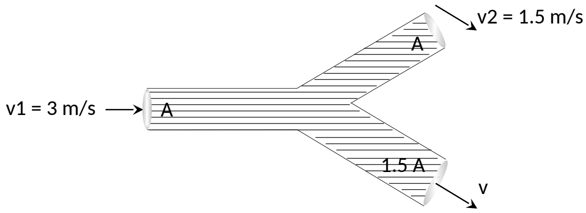
a) 1 b) $\frac{2a^2\rho g}{9\eta^2}$ c) $\frac{2a^2(\rho-\sigma)g}{9\eta}$ d) None of these

158. A solid sphere of volume V and density ρ floats at the interface of two immiscible liquids of densities ρ_1 and ρ_2 respectively. If $\rho_1 < \rho$ ¿ ρ_2, then the ratio of volume of the parts of the sphere in upper and lower liquid is

a) $\frac{\rho-\rho_2}{\rho_2-\rho}$ b) $\frac{\rho_2-\rho}{\rho-\rho_1}$ c) $\frac{\rho+\rho_1}{\rho+\rho_2}$ d) $\frac{\rho+\rho_2}{\rho+\rho_1}$

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

fluid is



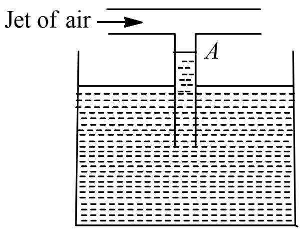
a) $3.0\,m/s$ b) $1.5\,m/s$ c) $1.0\,m/s$ d) $2.25\,m/s$

160. Air is streaming past a horizontal air plane wing such that its speed is $120\,m\,s^{-1}$ over the upper surface and $90\,m\,s^{-1}$ at the lower surface. If the density of air is $1.3\,kg\,m^{-3}$, what will be the gross life on the wing? If the wing is $10\,m$ long and has an average width of 2 m,
a) 81.9 N b) 8.19 kN c) 81.9 kN d) 819 kN

161. A spherical drop of water has radius 1 mm if surface tension of water is $70\times10^{-3}\,Nm^{-1}$, difference of pressure between inside and outside of the spherical drop is
a) $35\,Nm^{-2}$ b) $70\,Nm^{-2}$ c) $140\,Nm^{-2}$ d) Zero

162. Construction of submarines is based on
a) Archimedes principle b) Bernoulli's theorem c) Pascal's law d) Newton's laws

163. Water stands at level A in the arrangement shown in the figure. What will happen if a jet of air is gently blown into the horizontal tube in the direction shown in the figure?



a) Water will rise above A in the capillary tube
b) Water will fall below A in the capillary tube
c) There will be no effect on the level of water in the capillary tube
d) Air will emerge from end B in the form of bubbles

164. A cylinder of mass m and density ρ hanging from a string is lowered into a vessel of cross-sectional area A containing a liquid of density $\sigma\,(¿\rho)$ until it is fully immersed. The increase in pressure at the bottom of the vessel is
a) Zero b) $\frac{mg}{A}$ c) $\frac{mg\rho}{\sigma A}$ d) $\frac{m\sigma g}{\rho A}$

165. A bird is sitting in a large closed cage which is placed on a spring balance. It records a weight of 5N. The bird of mass 0.5 kg files upward in the cage with an acceleration of $2\,m\,s^{-2}$. The spring balance will now record a weight of
a) 4 N b) 5 N c) 6 N d) 7 N

166. A square plate of $0.1\,m$ side moves parallel to a second plate with a velocity of $0.1\,m/s$, both plates being immersed in water. If the viscous force is $0.002\,N$ and the coefficient of viscosity is 0.01 poise, distance between the plates in m is
a) 0.1 b) 0.05 c) 0.005 d) 0.0005

167. According to Bernoulli's equation
$\frac{P}{\rho g}+h+\frac{1}{2}\frac{v^2}{g}=¿$constant

The terms A, B and C are generally called respectively

a) Gravitational head, pressure head and velocity head

b) Gravity, gravitational head and velocity head

c) Pressure head, gravitational head and velocity head

d) Gravity, pressure and velocity head

168. Two water pipes P and Q having diameter 2×10^{-2} m and 4×10^{-2} m respectively are joined in series with the main supply line of water. The velocity f water flowing in pipe P is

a) 4 times that of Q b) 2 times that of Q c) 1/2 times that of Q d) 1/4 times that of Q

169. For a liquid which is rising in a capillary, the angle of contact is

a) Obtuse b) $180°$ c) Acute d) $90°$

170. Work done forming a liquid drop of radius R is W_1 and that of radius $3R is W_2$. The ratio of work done is

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

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

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

172. The onset of turbulence in a liquid is determined by

a) Pascal's law b) Magnus effect c) Reynold's number d) Bernoulli's principle

173. A tank of height H is fully filled with water. If the water rushing from a hole made in the tank below the free surface, strikes the floor at maximum horizontal distance, then the depth of the hole from the free surface must be

a) $\left(\frac{3}{4}\right)H$ b) $\left(\frac{2}{3}\right)H$ c) $\left(\frac{1}{4}\right)H$ d) $\left(\frac{1}{2}\right)H$

174. In a hydraulic press the small cylinder has a diameter of $'d_1' cm$, while the large piston has a diameter of $'d_2' cm$. If a force $'F_1'$ is applied to a small piston, the force on the large piston $'F_2'$ is given by

a) $F_2=\frac{d_2^2}{d_1^2}F_1$ b) $F_2=\frac{d_1^2}{d_2^2}F_1$ c) $F_2=\frac{d_1^2}{d_2^2}\frac{1}{F_1}$ d) $F_2=\frac{d_2^2}{d_1^2}\frac{1}{F_1}$

175. On which of the following, the terminal velocity of a solid ball in a viscous fluid is independent?

a) Area of cross-section b) Height of the liquid c) Density of the ball d) Density of the liquid

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

a) $10\,m$ b) $20\,m$ c) $60\,m$ d) $30\,m$

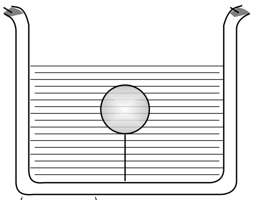
177. A sphere of radius R is gently dropped into liquid of viscosity η in a vertical uniform tube. It attains a terminal velocity v. Another sphere of radius $2R$ when dropped into the same liquid, will attains its terminal velocity

a) v b) $2v$ c) $4v$ d) $9v$

178. When two soap bubbles of radius r_1 and $r_2(r_2>r_1)$ coalesce, the radius of curvature of common surface is

a) (r_2-r_1) b) (r_2+r_1) c) $\frac{r_2-r_1}{r_1r_2}$ d) $\frac{r_2r_1}{r_2-r_1}$

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

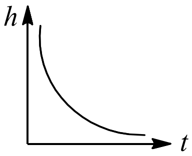


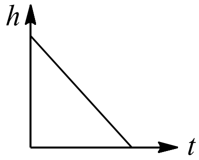
a) $\left(\frac{\eta-1}{\eta}\right)mg$ b) ηmg c) $\frac{mg}{\eta-1}$ d) $(\eta-1)mg$

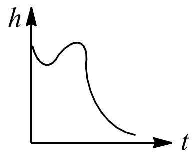
180. A liquid does not wet the sides of a solid, if the angle of contact is

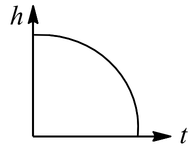
a) Obtuse b) $90°$ c) acute d) Zero

181. Water in a vessel of uniform cross-section escapes through a narrow tube at the base of the vessel. Which graph given below represents the variation of the height h of the liquid with time t?

a) 

b) 

c) 

d) 

182. A ring is cut from a platinum tube 8.5 cm internal diameter and 8.7 cm external diameter. It is supported horizontally from a pan of a balance so, that it comes in contact with the water is in glass vessel. If an extra 3.47 g-wt is required to pull it away from water, surface tension of water is

a) $72.07\, dyne\, cm^{-1}$ b) $70.80\, dyne\, cm^{-1}$ c) $65.35\, dyne\, cm^{-1}$ d) $60.00\, dyne\, cm^{-1}$

183. We have two (narrow) capillary tubes T_1 and T_2. Their lengths are l_1 and l_2 and radii of cross-section are r_1 and r_2 respectively. The rate of flow of water under a pressure difference P through tube T_1 is $8\, cm^3/sec$. If $l_1=2l_2$ and $r_1=r_2$, what will be the rate of flow when the two tubes are connected in series and pressure difference across the combination is same as before $(¿P)$

a) $4\, cm^3/sec$ b) $(16/3)\, cm^3/sec$ c) $(8/17)\, cm^3/sec$ d) None of these

184. A U-tube is partially filled with water. Oil which does not mix with water is next poured into one side until water rises by 25 cm. On the other side, if the density of oil be 0.8, the oil level will stand higher than the water level by

a) 6.25 cm b) 12.50 cm c) 31.25 cm d) 62.50 cm

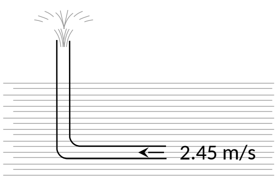
185. The potential energy of molecule on the surface of a liquid compared to one inside the liquid is

a) Zero b) Lesser c) Equal d) Greater

186. Two metal spheres are falling through a liquid of density $2\times10^3\, kg/m^3$ with the same uniform speed. The material density of sphere 1 and sphere 2 are $8\times10^3 kg/m^3$ and $11\times10^3 kg/m^3$ respectively. The ratio of their radii is

a) $\frac{11}{8}$ b) $\sqrt{\frac{11}{8}}$ c) $\frac{3}{2}$ d) $\sqrt{\frac{3}{2}}$

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



a) Zero b) $20.0\, cm$ c) $10.6\, cm$ d) $40.0\, cm$

188. By inserting a capillary tube upto a depth l in water, the water rises to a height h. If the lower end of the capillary tube is closed inside water and the capillary is taken out and closed end opened, to what height the water will

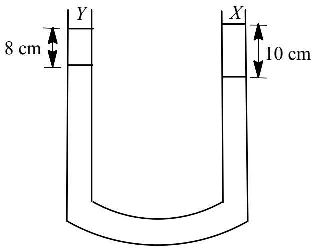
remain in the tube, when $l>h$?

a) Zero b) $l+h$ c) $2h$ d) h

189. An aeroplane of mass 3×10^4 kg and total wing area of $120\,m^2$ is in a level flight at some height. The difference in pressure between the upper and lower surface of its wings in kilo pascals is $(g=10\,ms^{-2})$

a) 2.5 b) 5.0 c) 10.0 d) 12.5

190. A liquid X of density 3.36 g cm^{-3} is poured in a U-tube, which contains Hg. Another liquid Y is poured in left arm with height 8 cm, upper levels of X and Y are same. What is density of Y?



a) $0.8\,gcc^{-1}$ b) $1.2\,gcc^{-1}$ c) $1.4\,gcc^{-1}$ d) $1.6\,gcc^{-1}$

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

a) $2\pi a$ b) A c) $\frac{a}{2\pi}$ d) $\frac{a}{\pi}$

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

a) $10\,N$ b) $9\,N$ c) $8\,N$ d) $7\,N$

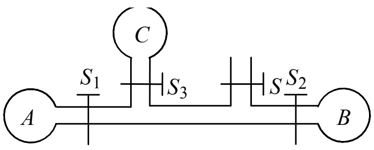
193. An aquarium tank is in the shape of a cube with one side a 4m tall glass wall. When the tank is half filled and the water is 2 m deep, the water exerts a force F on the wall. What force does the water exerts on the wall when the tank is full and the water is 4 m drop?

a) $1/2\,F$ b) F c) $2\,F$ d) $4\,F$

194. Let W be the work done, when a bubble of volume V is formed from a given solution. How much work is required to be done to form a bubble of volume $2\,V$?

a) W b) $2\,W$ c) $2^{1/3}\,W$ d) $4^{1/3}\,W$

195. The 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 volume of A and B increasing

c) Volume of A, B and C will become equal in equilibrium

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

196. The surface energy of a liquid drop is u. It is sprayed into 1000 equal droplets. Then its surface energy becomes

a) u b) $10\,u$ c) $100\,u$ d) $1000\,u$

197. $16\,cm^3$ Of water flows per sec through a capillary tube of radius a cm and of length l cm when connected to a pressure head of h cm of water. If a tube of the same length and radius $a/2$ cm is connected to the same pressure head, the quantity of water flowing through the tube per second will be

a) $16\,cm^3$ b) $1\,cm^3$ c) $4\,cm^3$ d) $8\,cm^3$

198. A drop of oil is placed on the surface of water then it will spread as a thin layer because

a) surface tension tends to give the oil a spherical surface

b) surface tension of water is greater than that of oil

c) both oil and water have nearly equal surface tension

d) oil is lighter than water

199. An air-tight cage with a parrot sitting in it is suspended from the spring balance. The parrot starts flying. The reading of the spring balance will

a) Increase b) Decrease c) Not change d) Be zero

200. The relative velocity of two parallel layers of water is $8\,cm\,s^{-1}$. If the perpendicular distance between the layers is 0.1 cm, then velocity gradient will be

a) $40\,s^{-1}$ b) $50\,s^{-1}$ c) $60\,s^{-1}$ d) $80\,s^{-1}$

201. Two rain drops falling through air have radii in the ratio 1:2. They will have terminal velocity in the ratio

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

202. Three capillaries of length $L, L/2 \wedge L/3$ are connected in series. Their radii are $r, r/2 \wedge r/3$ respectively. Then, if stream-line flow is to be maintained and the pressure across first capillary is p, then the

a) pressure difference across the end of second capillary is $8p$

b) pressure difference across the third capillary is $43p$

c) pressure difference across the end of second capillary is $16p$

d) pressure difference across the third capillary is $56p$

203. The excess pressure inside a spherical drop of water is four time that of another drop. Then their respective mass ratio is

a) 1:16 b) 8:1 c) 1:4 d) 1:64

204. The work done in increasing the size of a rectangular soap film with dimensions $8\,cm \times 3.75$ cm to $10\,cm \times 6\,cm$ is 2×10^{-4} J. The surface tension of the film in $N\,m^{-1}$ is

a) 1.65×10^{-2} b) 3.3×10^{-2} c) 6.6×10^{-2} d) 8.25×10^{-2}

205. 10 cm long wire is placed horizontally on the surface of water and is gently pulled up with a force of 2×10^{-2} N to keep the wire in equilibrium. The surface tension of water in $N\,m^{-1}$ is

a) 0.002 b) 0.001 c) 0.2 d) 0.1

206. Water rises in a capillary tube to a height h. Choose the false statement regarding rise from the following

a) On the surface of Jupiter, height will be less than h

b) In a lift, moving up with constant acceleration, height is less than h

c) On the surface of the moon, the height is more than h

d) In a lift moving down with constant acceleration height is less than h

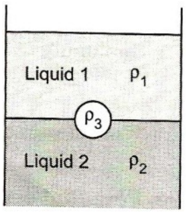
207. A marble of mass x and diameter $2r$ is gently released a tall cylinder containing honey. If the marble displaces mass $y(¿x)$ of the liquid, then the terminal velocity is proportional to

a) $(x+y)$ b) $(x-y)$ c) $\frac{x+y}{r}$ d) $\frac{(x-y)}{r}$

208. An air bubble of radius $10^{-2}\,m$ is rising up at a steady rate of $2 \times 10^{-3}\,ms^{-1}$ through a liquid of density $1.5 \times 10^{3}\,kg\,m^{-3}$, the coefficient of viscosity neglecting the density of air, will be $(g = 10\,ms^{-2})$

a) 23.2 units b) 83.5 units c) 334 units d) 167 units

209. A jar id filled with two non-mixing liquids 1 and 2 having densities ρ_1 and ρ_2 respectively. A solid ball, made of a material of density ρ_3, is dropped in the jar. It comes to equilibrium in the position shown in the figure. Which of the following is true for $\rho_1, \rho_2 \wedge \rho_3$?



a) $\rho_3<\rho_1<\rho_2$ b) $\rho_1<\rho_3<\rho_2$ c) $\rho_1<\rho_2<\rho_3$ d) $\rho_1<3<\rho_2$

210. 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, the viscous force acting on the ball is

a) $Mg\left(1\frac{d_2}{d_1}\right)$ b) $Mg\frac{d_1}{d_2}$ c) $Mg(d_1-d_2)$ d) Mgd_1d_2

211. A small tiny lead shot is gently dropped on the surface of a viscous liquid

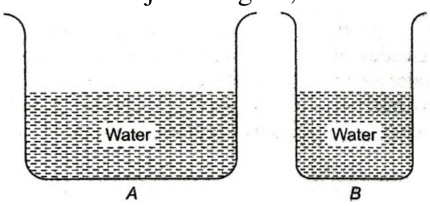
a) The lead shot will fall with an acceleration equal to g at that place

b) The velocity of lead shot will decrease with time

c) The velocity of lead shot will increase continuously

d) The velocity of lead shot will reach steady value after sometime

212. From the adjacent figure, the correct observation is



a) the pressure on the bottom of the tank A is greater than at the bottom of B

b) the pressure on the bottom of the tank A smaller than at the bottom of B

c) the pressure depends on the shape of the container

d) the pressure on the bottom of A and B is the same

213. A sphere liquid drop of radius R is divided into eight equal to droplets. If surface tension is T, then the work done in this process will be

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

214. A cylinder is filled with liquid of density d upto a height h. If the cylinder is at rest, then the mean pressure of the walls is

a) $hdg/4$ b) $hdg/2$ c) $2hdg$ d) hdg

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

a) $\frac{V}{16}$ b) $\frac{V}{17}$ c) $\frac{16V}{17}$ d) $\frac{17V}{16}$

216. A cubical block of wooden edge I and a density ρ floats in water of density2ρ. The lower surface of cube just touches the free end of a massless spring of force constant k fixed at the bottom of the vessel. The weight w put over the block so that it is completely immersed in water without wetting the weight is

a) $a(l\rho g+k)$ b) $a(l^2\rho g+k)$ c) $a\left(\frac{l\rho g}{2}+2k\right)$ d) $a\left(l^2\rho g+\frac{k}{2}\right)$

217. An object weighs m_1 in a liquid of density d_1 and that in liquid of density d_2 is m_2. The density d of the object is

a) $d=\frac{m_2 d_2-m_1-d_1}{m_2-m_1}$ b) $d=\frac{m_1 d_1-m_2-d_2}{m_2-m_1}$ c) $d=\frac{m_2 d_1-m_1-d_2}{m_1-m_2}$ d) $d=\frac{m_1 d_2-m_2-d_1}{m_1-m_2}$

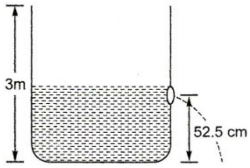
218. Two pieces of glass plate one upon the other with a little water in between them cannot be separated easily because of

a) Inertia b) Pressure c) Surface tension d) Viscosity

219. Two capillary tubes of same radius r but of lengths l_1 and l_2 are fitted in parallel to the bottom of a vessel. The pressure head is P. What should be the length of a single tube that can replace the two tubes so that the rate of flow is same as before

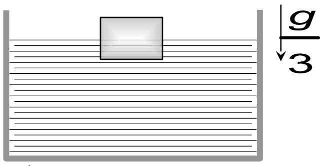
a) l_1+l_2 b) $\frac{1}{l_1}+\frac{1}{l_2}$ c) $\frac{l_1 l_2}{l_1+l_2}$ d) $\frac{1}{l_1+l_2}$

220. Water is filled in a cylindrical container to a height of 3m. The ratio of the cross-sectional area of the orifice and the beaker is 0.1 The square of the speed of the liquid coming out from the orifice is$(g=10\,ms^{-2})$



a) $50\,m^2 s^{-2}$ b) $50.5\,m^2 s^{-2}$ c) $51\,m^2 s^{-2}$ d) $52\,m^2 s^{-2}$

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



a) $\frac{1}{2}$ b) $\frac{3}{8}$ c) $\frac{2}{3}$ d) $\frac{3}{4}$

222. Two tubes $A \wedge B$ are in series. Radius of $A\,is\,R$ and that of $B\,is\,2R$. If water flows through A with velocity then velocity of water through $B$is

a) $\frac{v}{2}$ b) v c) $\frac{v}{4}$ d) $\frac{v}{8}$

223. A hollow cylinder of mass m made heavy at its bottom is floating vertically in water. It is tilled from its vertical position through an angle θ and is left. The restoring force acting on it is

a) $mg\cos\theta$ b) $mg\sin\theta$ c) $mg\left[\frac{1}{\cos\theta}-1\right]$ d) $mg\left[\frac{1}{\cos\theta}+1\right]$

224. With an increase in temperature, surface tension of liquid (except molten copper and cadmium)

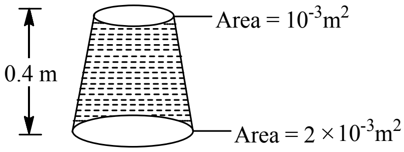
a) increases b) remain same

c) decreases d) first decrease and then increases

225. A body floats in water with 40% of its volume outside water. When the same body floats in an oil, 60% of its volume remains outside oil. The relative density of oil is

a) 0.9 b) 1.0 c) 1.2 d) 1.5

226. A uniform tapering vessel shown in figure is filled with liquid of density $900\,kg\,m^{-3}$. The force that acts on the base of the vessel due to liquid is (take g =$10\,m\,s^{-2}$)

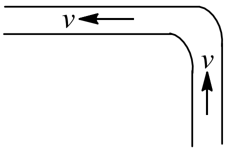


a) 3. 6 N b) 7.2 N c) 9. 0 N d) 12. 0 N

227. At critical temperature, the surface tension of a liquid is

a) Zero
b) Infinity
c) The same as that at any other temperature
d) Cannot be determined

228. A fire hydrant delivers water of density ρ at a volume rate L. The water travels vertically upwards 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 water on the corner of the hydrant is



a) Zero b) pvL c) $\sqrt{2}\,pvL$ d) $2\,pvL$

229. In stream line flow of liquid, the total energy of liquid is constant at

a) all points b) inner points c) outer points d) None of these

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

a) Greater than the work done by air friction in the second $100\,m$
b) Less than the work done by air friction in the second $100\,m$
c) Equal to $100\,mg$
d) Greater than $100\,mg$

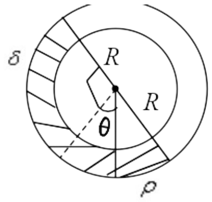
231. A trough contains mercury to a depth of 3.6 cm. If some amount of mercury is poured in it then height of mercury in the trough will be

a) 3.6 cm b) 7.2 cm c) 6 cm d) None of these

232. A spherical solid ball of volume V is made of a material of density $\rho_2 (\rho_2 < \rho_1)$. [Assume that the liquid applies a viscous force on the ball that is proportional to the square of its speed $v, ie, F_{viscous} = -kv^2 (k > 0)$ ¿. The terminal speed of the ball is

a) $\sqrt{\frac{Vg(\rho_2 < \rho_2)}{k}}$ b) $\frac{Vg\rho_1}{k}$ c) $\sqrt{\frac{Vg\rho_1}{k}}$ d) $\frac{Vg(\rho_1 < \rho_2)}{k}$

233. A uniform long tube is bent into a circle of radius R and it lies in a vertical plane. Two liquids of same volume but densities ρ and δ fill half the tube. The angle θ is



a) $\tan^{-1}\left(\frac{\rho-\delta}{\rho+\delta}\right)$ b) $\tan^{-1}\frac{\rho}{\delta}$ c) $\tan^{-1}\frac{\delta}{\rho}$ d) $\tan^{-1}\left(\frac{\rho+\delta}{\rho-\delta}\right)$

234. If two soap bubbles of different radii are connected by a tube

a) air flows from the bigger bubble to the smaller bubble till the sizes become equal

b) air flows from bigger bubble to the smaller bubble till the sizes are interchanged

c) air flows from the smaller bubble to the bigger

d) there is no flow of air

235. The top surface of an incompressible liquid is open to the atmosphere. The pressure at a depth P_1. How does the pressure P_2at depth $h_2=2h_1$ compare with P_1?

a) $P_2>2P_1$ b) $P_2=2P_1$ c) $P_2<2P_1$ d) $P_2=P_1$

236. A frame made of a metallic wire enclosing a surface area A is covered with a soap film. If the area of the frame of metallic wire is reduced by 50%, the energy of the soap film will be changed by

a) 100% b) 75% c) 50% d) 25%

237. Two cylinders of same cross-section and length L but made of two material of densitites ρ_1 and ρ_2 (in CGS units) are cemented together to form a cylinder of length$2L$. If the combination floats in water with a length $L/2$ above the surface of water and $\rho_1<\rho_2$, then

a) $\rho_1>1$ b) $\rho_1<3/4$ c) $\rho_1>1/2$ d) $\rho_1>3/4$

238. A frame made of metallic wire enclosing a surface area A is covered with a soap film. If the area of the frame of metallic wire is reduced by 50% , the energy of the soap film will be changed by

a) 100% b) 75% c) 50% d) 25%

239. The glycerin of density $1.25\times10^3\,kg\,m^{-3}$ is flowing through a conical tube with end radii 0.1 m and 0.04 m respectively. The pressure difference across the ends is $10\,N\,m^{-2}$. The rate of flow of glycerine through the tube is

a) $6.4\times10^{-2}m^2s^{-1}$ b) $6.4\times10^{-4}m^3s^{-1}$ c) $12.8\times10^{-2}m^3s^{-1}$ d) $12.8\times10^3\,m^3s^{-1}$

240. Water rises in a capillary tube to a height$h$. It will rise to a height more than h

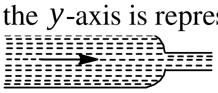
a) On the surface of sun

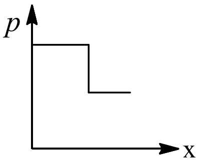
b) In a life moving down with an acceleration

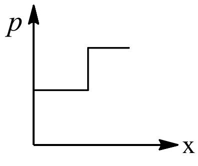
c) At the poles

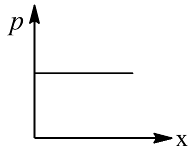
d) In a lift moving up with an acceleration

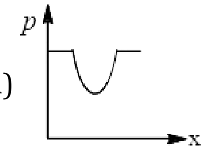
241. Water flows through a frictionless tube with a varying cross-section as shown in Fig (i). Pressure p at points along the y-axis is represented by



a) 

b) 

c) 

d) 

242. Blood is flowing at the rate of $200\,c\,m^3s^{-1}$ in a capillary of cross sectional area $0.5\,m^2$. The velocity of flow, in $mm\,s^{-1}$, is

a) 0.1 b) 0.2 c) 0.3 d) 0.4

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

a) $2p$ b) $8p$ c) $4p$ d) $7p$

244. A liquid of density 800 kg m^3 is filled in a tank open at the top. The pressure of the liquid at the bottom of the tank is 6.4 atm. The velocity of efflux through a hole at the bottom is(1 atm = 10^5 Nm^{-2})

a) $10\ ms^{-1}$ b) $20ms^{-1}$ c) $30ms^{-1}$ d) $40ms^{-1}$

245. A container with square base of side a hight H with a liquid. A hole is made at a depth h from the free surface of water. With what acceleration the container must be accelerated, so that the water does not come out?

a) G b) $\frac{g}{2}$ c) $\frac{2gH}{2}$ d) $\frac{2gh}{a}$

246. Work done in increasing the size of soap bubble from radius of 3 cm to 5 cm is nearly (surface tension of soap solution¿$0.03\ Nm^{-1}$¿

a) $0.2\pi\ mJ$ b) $2\pi\ mJ$ c) $0.4\pi\ mJ$ d) $4\pi\ mJ$

247. A small iron sphere is dropped from a great height. It attains its terminal velocity after having fallen 32 m. Then, it covers the rest of the path with terminal velocity only. The work done by air friction during the first 32 m of fall is W_1. The work done by air friction during the subsequent 32 m fall is W_2. Then

a) $W_1 > W_2$ b) $W_1 < W_2$ c) $W_1 = W_2$ d) $W_2 = 32W_1$

248. Water flows in a streamlined manner through a capillary tube of radius a, the pressure difference being P and the rate of flow Q. If the radius is reduced to $a/2$ and the pressure increased to $2P$, the rate of flow becomes

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

249. A cylindrical vessel is filled with equal amounts of weight of mercury on water. The overall height of the two layers is 29.2 cm, specific gravity of mercury is 13.6. Then the pressure of the liquid at the bottom of the vessel is

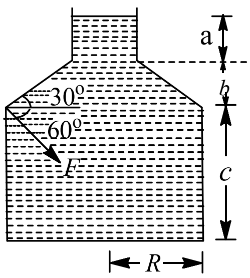
a) 29.2 cm of water b) 29.2 /13.6 cm of mercury

c) 4 cm of mercury d) 15.6 cm of mercury

250. The pressure on a swimmer 20 m below the surface of water at sea level is

a) 1.0 atm b) 2.0 atm c) 2.5 atm d) 3.0 atm

251. A jar shown in figure is filled with a liquid of density ρ. The jar is placed in vacuum. Cross-section of the jar is circular and base is having a radius R. The force exerted by the liquid column on the base of the jar is



a) $\rho g(a+b+c)\pi R^2$ b) Less than $\rho g(a+b+c)\pi R^2$

c) Greater than $\rho g(a+b+c)\pi R^2$ d) $2\rho g(a+b+c)\pi R^2$

252. Water flows steadily through a horizontal pipe of variable cross-section. If the pressure of water is p at a point where flow speed is v, the pressure at another point where the flow of speed is $2v$, is (take density of water as ρ)

a) $p-\frac{3\rho v^2}{2}$ b) $p-\frac{\rho v^2}{2}$ c) $p-\frac{3\rho v^2}{4}$ d) $p-\rho v^2$

253. A horizontal pipe of non-uniform cross-section allows water to flow through it with a velocity $1\ ms^{-1}$ when pressure is 50 kPa at a point. If the velocity of flow has to be $2\ ms^{-1}$ at some other point, the pressure at that point should be

a) 50 kPa b) 100 kPa c) 48.5 kPa d) 24.25 kPa

254. A sphere of mass M and radius R is dropped in a liquid, then terminal velocity of sphere is proportional to

a) R b) $\frac{1}{R}$ c) R^2 d) $\frac{1}{R^2}$

255. Three liquids of equal masses are taken in three identical cubical vessels A, B and C. Their densities are

$\rho_A, \rho_B \wedge \rho_C$ respectively but $\rho_A < \rho_B < \rho_C$. below the force extract by the liquid on the base of cubical vessel is

a) maximum in vessel C b) maximum in vessel C

c) the same in all the vessels d) maximum in vessel A

256. The excess pressure inside one soap bubble is three times that inside a second soap bubble, then the ratio of their surface areas is

a) 1:9 b) 1:3 c) 3:1 d) 1:27

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

a) 8 b) 4 c) 3 d) Zero

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

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

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

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

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

259. A man is carrying a block of a certain substance (of density $1000\, kg\, m^{-3}$) weighing $1\, kg$ in his left hand and a bucket filled with water and weighing $10\, kg$ in the right hand. He drops the block into the bucket. How much load does he carry in his right hand now

a) $9\, kg$ b) $10\, kg$ c) $11\, kg$ d) $12\, kg$

260. A horizontal pipe line carries water in streamline flow. At a point where the cross-sectional area is 10 cm^2 the water velocity is 1 ms^{-1} and pressure is 2000 Pa. The pressure of water at another point where the cross-sectional area is 5 cm^2, is

a) 200 Pa b) 400 Pa c) 500 Pa d) 800 Pa

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

a) Pressure difference b) Volume of the liquid collected

c) Length of the capillary tube d) Inner radius of the capillary tube

262. Two rain drops reach the earth with different terminal velocities having ratio 9:4. Then the ratio of their volume is

a) 3:2 b) 4:9 c) 9:4 d) 27:8

263. Radius of one arm of hydraulic lift is four times of radius of other arm. What force should be applied on narrow arm to lift 100kg?

a) 26.5 N b) 62.5 N c) 6.25 N d) 8.3 N

264. The terminal speed of a sphere of gold $(density = 19.5\, kg\, m^{-3})$ is $0.2\, ms^{-1}$ in a viscous liquid $(density = 1.5\, kg\, m^{-3})$. Then the terminal speed of a sphere of silver $(density = 10.5\, kg\, m^{-3})$ of the same size in the same liquid is

a) $0.1\, ms^{-1}$ b) $1.133\, ms^{-1}$ c) $0.4\, ms^{-1}$ d) $0.2\, ms^{-1}$

265. Two soap bubbles combine to form a single bubble. In this process, the change in volume and surface area are respectively V and A. If p is the atmospheric pressure, and T is the surface tension of the soap solution, the following relation is true.

a) $4pV + 3TA = 0$ b) $3pV - 4TA = 0$ c) $4pV - 3TA = 0$ d) $3pV + 4TA = 0$

266. What change in surface energy will be noticed when a drop of radius R splits up into 1000 droplets of radius r, surface tension T?

a) $4\pi R^2 T$ b) $7\pi R^2 T$ c) $16\pi R^2 T$ d) $36\pi R^2 T$

267. A vessel whose bottom has round holes with diameter of 1 mm is filled with water. Assuming that surface tension acts only at holes, then the maximum height to which the water can be filled in vessel without leakage is (Surface tension of water is $75\times10^{-3} N m^{-1}$ and $g=10 m s^{-2}$)

a) 3 cm b) 0.3 cm c) 3 mm d) 3 m

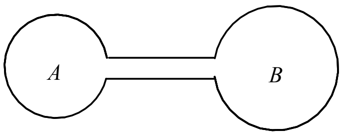
268. The surface tension of a liquid is $5 Nm^{-1}$. If a film is held on a ring of area $0.02 m^2$, its total surface energy is about

a) $2\times10^{-2} J$ b) $2.5\times10^{-2} J$ c) $2\times10^{-1} J$ d) $3\times10^{-1} J$

269. A water tank, open to the atmosphere, has a leak in it, in the form of a circular hole, located at a height h below the open surface of water. The velocity of the water coming out of the hole is

a) $\sqrt{gh/2}$ b) $\sqrt{gh}$ c) $\sqrt{2gh}$ d) $2\sqrt{gh}$

270. There is a small bubble at one end and bigger bubble at other end of a rod. What will happen?



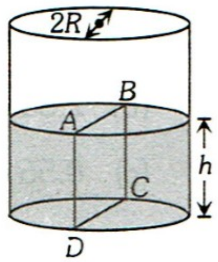
a) Smaller will grow until they collapse b) Bigger will grow until they collapse

c) Remain in equilibrium d) None of the above

271. The terminal velocity of spherical ball of radius a falling through a viscous liquid is proportional to

a) a b) a^2 c) a^3 d) a^{-1}

272. 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) ¿ $P_0\pi R^2+R\rho gh^2+2RT$ ∨¿

273. 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) 9/10

274. A wooden ball of density ρ is immersed in water of density ρ_0 to depth h and then released. The height H above the surface of water upto which the ball jump out of water is

a) Zero b) h c) $\frac{\rho_0 h}{\rho}$ d) $\left(\frac{\rho_0}{\rho}-1\right)h$

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

a) $7 m s^{-1}$ b) $8 m s^{-1}$ c) $9 m s^{-1}$ d) $10 m s^{-1}$

276. Water rises to a height of 10 cm in a capillary tube and mercury falls to a depth of 3.42 cm in the same capillary tube. If the density of mercury and water are $135°$ and $0°$ respectively, the ratio of surface tension of water and mercury is

a) 1 : 0.15 b) 1 : 3 c) 1 : 6.5 d) 1.5 : 1

277. Two drops of equal radius coalesce to form a bigger drop. What is ratio of surface energy of bigger drop to smaller one?

a) $2^{1/2}:1$ b) $1:1$ c) $2^{1/3}:1$ d) None of the above

278. Two helium filled balloons are floating next to each other at the ends of strings tied to a cable. The facing surfaces of the balloons are separated by 1 to $2\,cm$. If you blow through the opening between the balloons, then

a) They more away from each other
b) They move towards each other
c) They are unaffected
d) Nothing can be said about their separation

279. When the temperature increases, the viscosity of

a) gas decreases and liquid increases
b) gas increases and liquid decreases
c) gas and liquid increases
d) gas and liquid decreases

280. Under a pressure head, the rate of orderly volume flow of liquid through a capillary tube is Q. If the length of capillary tube were doubled and the diameter of the bore is halved, the rate of flow would become

a) $\frac{Q}{4}$ b) $16Q$ c) $\frac{Q}{8}$ d) $\frac{Q}{32}$

281. One end of a uniform glass capillary tube of radius $r=0.025\,cm$ is immersed vertically in water to a depth $h=1\,cm$. The excess pressure in Nm^{-2} required to blow an air bubble out of the tube (Surface tension of water = $7 \times 10^{-2} Nm^{-1}$, Density of water = $10^3 kg\,m^{-3}$, Acceleration due to gravity= $10 ms^{-2}$)

a) 0.0048×10^5 b) 0.0066×10^5 c) 1.0048×10^5 d) 1.0066×10^5

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

a) $\frac{1}{2} A\rho g h$ b) $\frac{1}{3} A\rho g h$ c) $\frac{1}{6} A\rho g h$ d) $\frac{2}{3} A\rho g h$

283. In a capillary rise experiment, the water level rises to a height of 5 cm. If the same capillary tube is placed in water such that only 3 cm of the tube projects outside the water level, then

a) water will begin to overflow through the capillary
b) angle of contact decreases
c) angle of contact increases
d) water will rise to a level less than 3 cm

284. The excess pressure in a bubble of radius R of a gas in a liquid of surface tension S is

a) $\frac{2S}{R}$ b) $\frac{2R}{S}$ c) $\frac{2S}{R^2}$ d) $\frac{2R^2}{S}$

285. Eight equal drops of water are falling through air with a steady velocity of $10\,cms^{-1}$. if the drops combine to form a single drop big size, then the terminal velocity of this big drop is

a) $80\,cms^{-1}$ b) $30\,cms^{-1}$ c) $10\,cms^{-1}$ d) $40\,cms^{-1}$

286. Velocity of water in a river is

a) Same everywhere
b) More in the middle and less near its banks

c) Less in the middle and more near its banks
d) Increase from one bank to other bank

287. When a number of small droplets combine to form a large drop, then

a) energy is absorbed
b) energy is liberated
c) energy is neither liberated nor absorbed
d) process is independent of energy

288. Two very wide parallel glass plates are held vertically at a small separation r, and dipped in water of surface tension S. Some water climbs up in the gap between the plates. If p_0 is the atmospheric pressure, then the pressure of water just below the water surface in the region between the two plates is

a) $p_0 - \frac{2S}{r}$
b) $p_0 + \frac{2S}{r}$
c) $p_0 - \frac{4S}{r}$
d) $p_0 + \frac{4S}{r}$

289. Consider the following equation of Berouilli's theorem.

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

The dimensions of K/P are same as that of which of the following

a) Thrust
b) Pressure
c) Angle
d) Viscosity

290. A vessel whose bottom has round hole with diameter of 1 mm is filled with water. Assuming that surface tension acts only at hole, then the maximum height to which the water can be filled in vessel without leakage is(surface tension of water ¿ $7.5 \times 10^{-2} Nm^{-1} \wedge g = 10\, ms^{-2}$ ¿

a) 0.3 cm
b) 3 mm
c) 3 cm
d) 3 m

291. Bernoulli's theorem is a consequence of the law of conservation of

a) Momentum
b) Mass
c) Energy
d) angular momentum

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

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

293. Two mercury drop (each of radius r ¿ merge to form a bigger drop, if T is the surface tension is

a) $2^{5/3}\pi r^2 T$
b) $4\pi r^2 T$
c) $2\pi r^2 T$
d) $2^{8/3}\pi r^2 T$

294. Two spherical soap bubbles of radii a and b in vacuum coalesce under isothermal conditions. The resulting bubble has a radius given by

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

295. In which one of the following cases will the liquid flow in a pipe be most streamlined

a) Liquid of high viscosity and high density flowing through a pipe of small radius
b) Liquid of high viscosity and low density flowing through a pipe of small radius
c) Liquid of low viscosity and low density flowing through a pipe of large radius
d) Liquid of low viscosity and high density flowing through a pipe of large radius

296. An iceberg is floating in water. The density of ice in the iceberg is $917\, kg\, m^{-3}$ and the density of water is $1024\, kg\, m^{-3}$

a) 5%
b) 10%
c) 12%
d) 8%

297. Water is flowing continuously from a tap having an internal diameter $8 \times 10^{-3} m$. The water velocity as it leaves the tap is 0.4 m/s. The diameter of the water stream at a distance 2×10^{-1} m below the tap is close to

a) $7.5\times10^{-3}m$ b) $9.6\times10^{-3}m$ c) $3.6\times10^{-3}m$ d) $5.0\times10^{-3}m$

298. A spherical drop of water has 1 mm radius. If the surface tension of water is $70\times10^{-3}N\,m^{-1}$, then the difference of pressure between inside and outside of the spherical drop is

a) $35\,N\,m^{-2}$ b) $70\,N\,m^{-2}$ c) $140\,N\,m^{-2}$ d) Zero

299. A log of wood of mass $120\,kg$ floats in water. The weight that can be put on raft to make it just sink, should be (density of wood ¿$600\,kg/m^3$)

a) $80\,kg$ b) $50\,kg$ c) $60\,kg$ d) $30\,kg$

300. If a ball of steel $density\,\rho=7.8\,g\,cm^{-3}$¿ attains a terminal velocity of $10\,cms^{-1}$ when falling in a tank of water (coefficient of viscosity $\eta_{water}=8.5\times10^{-4}\,Pa-s$¿ then its terminal velocity in glycerine $(\rho=12\,g\,cm^{-3},\eta=13.2\,Pa-s)$ would be nearly

a) $1.06\times10^{-5}cms^{-1}$ b) $6.25\times10^{-4}cms^{-1}$ c) $6.45\times10^{-4}cms^{-1}$ d) $1.5\times10^{-5}cms^{-1}$

301. A cube floats in water with $1/3$rd parts is outside the surface of water and it floats in liquid with $3/4th$ part is outside the liquid then the density of liquid is

a) 8/3 b) 2/3 c) 4/3 d) 5/3

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

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

303. The density of ice and water are respectively $g\,cm^{-3}$. If m gram of ice melts , then change in its volume is

a) $y-\frac{x}{m}$ b) $m(y-x)$ c) $\frac{m}{y}-\frac{m}{x}$ d) my

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

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

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

a) $5\,m$ b) $10\,m$ c) $15\,m$ d) $20\,m$

306. Water is flowing in a pipe of diameter 4 cm with a velocity $3\,ms^{-1}$. The water then enters in to a pipe of diameter 2 cm. the velocity of water in the other pipe is

a) $3\,ms^{-1}$ b) $6\,ms^{-1}$ c) $12\,ms^{-1}$ d) $8\,ms^{-1}$

307. Two capillaries of length $L\wedge2L$ and of radii $R\wedge2R$ respectively are connected in series. The net rate of flow of fluid through them will be (Given, rate of the flow through single capillary, $X=\pi p\,R^4/8\eta L$)

a) $\frac{8}{9}X$ b) $\frac{9}{8}X$ c) $\frac{5}{7}X$ d) $\frac{7}{5}X$

308. Water is flowing through a pipe of constant cross-section. At some point the pipe becomes narrow and the cross-section is halved. The speed of water is

a) reduced to zero b) decreased by a factor of 2

c) increased by a factor of 2 d) unchanged

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

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

310. Water is flowing through a horizontal pipe of varying cross-section. If the pressure of water equals 2 cm of

mercury, where the velocity of the flow is $32\,cm\,s^{-1}$, what is the pressure at another point, where the velocity of flow is $65\,cm\,s^{-1}$?

a) 1.02 cm of Hg b) 1.88 cm of Hg c) 2.42 cm of Hg d) 1.45 cm of Hg

311. The excess of pressure inside the first soap bubble is three times that inside the second bubble is

a) 1:3 b) 1:9 c) 1:7 d) 9:1

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

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

313. The terminal velocity v of a spherical ball of lead of radius R falling through a viscous liquid varies with R such that

a) $\frac{v}{R}=¿$ constant b) $vR=¿$ constant c) $v=¿$ constant d) $\frac{v}{R^2}=¿$ constant

314. If the velocity head of a stream of water is equal to 10 cm, then its speed of flow is $(g=10\,ms^{-2})$

a) $10\,m\,s^{-1}$ b) $140\,m\,s^{-1}$ c) $1.4\,m\,s^{-1}$ d) $0.1\,m\,s^{-1}$

315. A river of salty water if flowing with a velocity $2\,ms^{-1}$. If the density of the water is $1.2\,gcc^{-1}$, then the kinetic energy of each cubic meter of water is

a) 2.4 J b) 24 J c) 2.4 Kj d) 4.8 kJ

316. If two ping pong ball are suspended near each other and a fast stream of air is produced within the space of the balls, the balls

a) Come nearer to each other b) Move away from each other

c) Remain in their original positions d) Move far away

317. A capillary tube of radius R and length L is connected in series with another tube of radius $R/2$ and length$L/4$. If the pressure difference across the two tubes taken together is p, then the ratio of pressure difference across the first tube to that across the second tube is

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

318. The neck and bottom of a bottle are 3 cm and 15 cm in radius respectively. If the cork is pressed with a force 12 N in the neck of the bottle, then force exerted on the bottom of the bottle is

a) 30 N b) 150 N c) 300 N d) 600 N

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

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

320. The meniscus of mercury in a capillary glass tube, is

a) Concave b) Plane c) Cylindrical d) convex

321. A ball of mass m and radius r is released in a viscous liquid. The value of its terminal velocity is proportional

a) $\frac{1}{r}$ b) $\frac{m}{r}$ c) $\sqrt{\frac{m}{r}}$ d) m only

322. Two stretched membranes of area $2\,cm^2$ and $3\,cm^2$ are placed in a liquid at the same depth. The ratio of pressure on them is

a) 1 : 1 b) 2 : 3 c) 3 : 2 d) $2^2:3^2$

323. An application of Bernoulli's equation for fluid flow is four in

a) Dynamic lift of an aeroplane
b) Viscosity meter
c) Capillary rise
d) Hydraulic press

324. A cylinder drum, open at the top, contains 15 L of water. It drains out through a small opening at the bottom. 5 L of water comes out in time t_1, the next 5 L in further time t_2 and the last 5 L in further time t_3. Then

a) $t_1 < t_2 < t_3$
b) $t_1 > t_2 > t_3$
c) $t_1 = t_2 = t_3$
d) $t_1 > t_2 = t_3$

325. An ice block floats in a liquid whose density is less than water. A part of block is outside the liquid. When whole of ice has melted, the liquid level will

a) Rise
b) Go down
c) Remain same
d) First rise then go down

326. A $10\, cm^3$ cube floats in water with a height of $4\, cm^3$ remaining above the surface. The density of the material form which the cube is made is

a) $0.6\, g\, cm^{-3}$
b) $1.0\, g\, cm^{-3}$
c) $0.4\, g\, cm^{-3}$
d) $0.24\, g\, cm^{-3}$

327. To what height should a cylindrical vessel be filled with a homogeneous liquid to make the force with which the liquid presses on the sides of the vessel equal to the force exerted by the liquid on the bottom of the vessel. If should be

a) Equal to the radius
b) Less than radius
c) More than radius
d) Four times of radius

328. Choose the correct statement(s) for a cricket ball that is spinning clockwise through air

S1 : Streamlines of air are symmetric around the ball
S2 : The velocity of air above the ball relative to it is larger than that below the ball
S3 : The velocity of air above the ball relative to it is smaller than that below the ball
S4 : There is a net upward force on the ball

a) S1, S2 and S4
b) S2 and S4
c) S4 only
d) S3 only

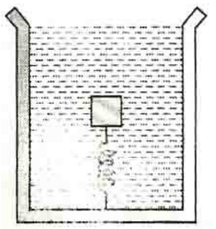
329. A vessel contains oil (density 0.8 g cm^{-3}¿ over mercury (density 136 g cm^{-3}¿. A homogenous sphere floats with half volume immersed in mercury and the other half in oil. The density of the material of the sphere in g cm^{-3} is

a) 12.8
b) 7.2
c) 6.4
d) 3.3

330. 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 in the capillary tube,

a) Water will come as a fountain from the capillary tube
b) Water will stay at a height of 12 cm in the capillary tube
c) The height of water in the capillary tube will be 10.3 cm
d) Water height flow down the sides of the capillary tube

331. A block is submerged in vessel filled with water by a spring attached to the bottom of the vessel. In equilibrium, the spring is compressed. The vessel now moves downwards with acceleration $a(¿g)$. The spring length



a) Will become zero
b) Will decrease but not zero

c) Will increase

d) May increase or decrease or remain constant

332. The cylindrical tube of spray pump has a cross-section of $8cm^2$, one end of which has 40 fine holes each of area $10^{-8}m^2$. If liquid flows inside the tube with a speed of $0.15\,m\,min^{-1}$, the speed with which the liquid is ejected through the hole is

a) $50\,ms^{-1}$ b) $5\,ms^{-1}$ c) $0.05\,ms^{-1}$ d) $0.5\,ms^{-1}$

333. Soap bubbles can be formed floating in air by blowing soap solution in air, with the help of a glass tube but not water bubbles. It because

a) The excess pressure inside water bubble being more due to large surface tension

b) The excess pressure inside water bubble being less du large surface tension

c) The excess pressure inside water bubble being more due to large viscosity

d) The excess pressure inside water bubble being less due to less viscosity

334. Two capillaries of radii r_1 andr_2, length l_1 and l_2 respectively are in series. A liquid of viscosity η is flowing through the combination under a pressure difference p. What is the rate of volume flow of liquid?

a) $\frac{\pi p}{8\eta}\left(\frac{l_4}{r_1^4}+\frac{l_4}{r_2^4}\right)^{-1}$ b) $\frac{8\pi p}{\eta}\left(\frac{l_1}{r_1^4}+\frac{l_2}{r_2^4}\right)$ c) $\frac{\pi p}{8\eta}\left(\frac{r_1^4}{l_1}+\frac{r_2^4}{l_2}\right)^{-1}$ d) $\frac{\pi p}{8\eta}\left(\frac{l_1}{r_1^4}+\frac{l_2}{r_2^4}\right)^{-1}$

335. The coefficient of viscosity for hot air is

a) Greater than the coefficient of viscosity of cold air

b) Smaller than the coefficient of viscosity for cold air

c) Same as the coefficient of viscosity for cold air

d) Increases or decrease depending on the external pressure

336. A water film is formed between two parallel wires of 10 cm length. The distance of 0.5 cm between the wires is increased by 1 mm. Which will be the work done?

(Surface tension of water =$72\,Nm^{-1}$¿

a) 288 erg b) 144 erg c) 72 erg d) 36 erg

337. Aerofils are so designed that the speed of air

a) On top side is more than on lower side

b) On top side is less than on lower side

c) Is same on both sides

d) Is turbulent

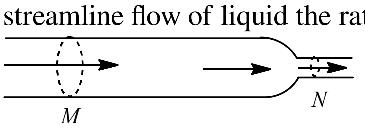
338. The height of a mercury barometer is $75\,cm$ at sea level and $50\,cm$ at the top of a hill. Ratio of density of mercury to that of air is 10^4. The height of the hill is

a) $250\,m$ b) $2.5\,km$ c) $1.25\,km$ d) $750\,m$

339. A rectangular plate $2\,m\times 3\,m$ is immersed in water in such a way that its greatest and least depth are 6m and 4m respectively from the water surface. The total thrust on the plate is

a) 294×10^3 N b) 294 N c) 100×10^3 N d) 400×10^3 N

340. Horizontal tube of non-uniform cross-section has radii of 0.1 m and 0.05 m respectively at $M$and N. For a streamline flow of liquid the rate of liquid flow is



a) Changing continuously with time

b) Greater at M than N

c) Greater at N than at M

d) Same at M and N

341. Surface tension of a soap solution is able of 2.0 cm diameter will be

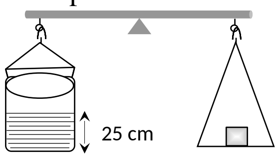
a) $7.6 \times 10^{-6} \pi$ J

b) $15.2 \times 10^{-6} \pi$ J

c) $1.9 \times 10^{-6} \pi$ J

d) $1 \times 10^{-4} \pi$ J

342. A cylinder containing water upto a height of $25\,cm$ has a hole of cross-section $1/4\,cm^2$ in its bottom. It is counterpoised in a balance. What is the initial change in the balancing weight when water begins to flow out



a) Increase of 12.5 *gm-wt*

b) Increase of 6.25 *gm-wt*

c) Decrease of 12.5 *gm-wt*

d) Decrease of 6.25 *gm-wt*

343. In making an alloy, a substance of specific gravity s_1 and mass m_1 is mixed with another substance of specific gravity s_2 and mass m_2 : then the specific gravity of the alloy is

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

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

c) $\frac{m_1+m_2}{\frac{m_1}{s_1}+\frac{m_2}{s_2}}$

d) $\frac{\frac{m_1}{s_1}+\frac{m_2}{s_2}}{m_1+m_2}$

344. At which of the following temperatures, the value of surface tension of water is minimum?

a) 4 °C

b) 25 °C

c) 50 °C

d) 75 °C

345. Streamline flow is more likely for liquid with

a) high density and low viscosity

b) low density and high viscosity

c) high density and high viscosity

d) low density and low viscosity

346. A body weight 50 g in air and 40 g in water. How much would it weigh in a liquid of specific gravity 1.5?

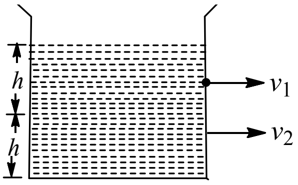
a) 30 g

b) 35 g

c) 65 g

d) 45 g

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



a) $\frac{1}{\sqrt{2}}$

b) $\frac{1}{4}$

c) $\frac{1}{2}$

d) $\frac{1}{2\sqrt{2}}$

348. A mercury drop of radius 1.0 cm is sprayed in to 10^6 droplets of equal size. The energy expended in this process is (surface tension of mercury is equal to $32 \times 10^{-2}\,Nm^{-1}$¿

a) $3.98 \times 10^{-4}\,J$

b) $8.46 \times 10^{-4}\,J$

c) $3.98 \times 10^{-2}\,J$

d) $3.98 \times 10^{-2}\,J$

349. Air is blown through a hole on a closed pipe containing liquid. Then the pressure will

a) Increase on sides

b) Increase downwards

c) Increase in all directions

d) Never increases

350. A block of wood weighs $4\,N$ in air and $3\,N$ when immersed in a liquid. The buoyant force in newton is

a) Zero b) 1 c) 3/4 d) 4/3

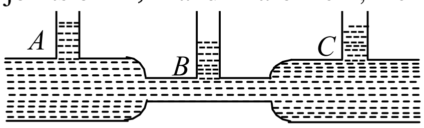
351. Water rises in plant fibres due to

a) Capillarity b) Viscosity c) fluid pressure d) Osmosis

352. The amount of work done in blowing a soap bubble such that its diameter increases from d to D is ($S=$¿ surface tension of solution)

a) $\pi(D^2-d^2)S$ b) $2\pi(D^2-d^2)S$ c) $4\pi(D^2-d^2)S$ d) $8\pi(D^2-d^2)S$

353. Three tubes A, B and C are connected to a horizontal pipe in which liquid is flowing. The radii of pipe at the joints of A, B and C are 2 cm, 1 cm and 2 cm respectively. The height of liquid



a) In A is maximum b) In A and B is equal c) Is same in all three d) In A and C is same

354. Two capillary of length L and $2L$ and of radii R and $2R$ are connected in series. The net rate of flow of fluid through them will be (given rate of the flow through single capillary, $X=\frac{\pi p R^4}{8\eta L}$)

a) $\frac{8}{9}X$ b) $\frac{9}{8}X$ c) $\frac{5}{7}X$ d) $\frac{7}{5}X$

355. The heat evolved for the rise of water when one end of the capillary tube of radius r is immersed vertically into water is (Assume surface tension $=T$ and density of water $=\rho$)

a) $\frac{2\pi T}{\rho g}$ b) $\frac{\pi T^2}{\rho g}$ c) $\frac{2\pi T^2}{\rho g}$ d) None of these

356. The height of the dam, in an hydroelectric power station is $10\,m$. In order to generate $1\,MW$ of electric power, the mass of water (in kg) that must fall per second on the blades of the turbine is

a) 10^6 b) 10^5 c) 10^3 d) 10^4

357. A steel ball is dropped in oil then,

a) the ball attains constant velocity after some time
b) the ball stops
c) the speed of ball will keep on increasing
d) None of the above

358. Water from a tap emerges vertically downwards with an initial speed of $1.0\,ms^{-1}$. The cross-sectional area of the tap is $10^{-4}\,m^2$. Assume that the pressure is constant throughout the stream of water and that the flow is steady. The cross-sectional area of the stream 0.15 m below the tap is

a) $1.0\times10^{-5}m^2$ b) $2\times10^{-5}m^2$ c) $5\times10^{-5}m^2$ d) $5\times10^{-4}m^2$

359. A tank 5m high is half filled with water and then is filled to the top with oil of density $0.85\,g\,cm^{-3}$. The pressure at the bottom of the tank, due to these liquids is

a) $1.85\,g\,dyne\,cm^{-3}$ b) $89.25\,g\,dyne\,cm^{-3}$ c) $462.5\,g\,dyne\,cm^{-3}$ d) $500\,g\,dyne\,cm^{-3}$

360. A container of height $10\,m$ which is open at the top, has water to its full height. Two small openings are made on the walls of the container one exactly at the middle and the other at the bottom. The ratio of the velocities with which water comes out from the middle and the bottom region respectively is

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

361. A layer of glycerine of thickness 1 mm is present between a large surface area and a surface area of $0.1\,m^2$. With what force the small surface is to be pulled, so that it can move with a velocity of $1\,ms^{-1}$? (Given that coefficient of viscosity = $0.07\,kg\,m^{-1}s^{-1}$)

a) 70 N b) 7 N c) 700 N d) 0.70 N

362. Two solid pieces, one of steel and the other of aluminum when immersed completely in water have equal weights. When the solid pieces are weighed in air

a) the weight of aluminium is half the weight of steel

b) steel piece will weigh more

c) they have the same weight

d) aluminium piece will weigh more

363. A denotes the area to the right on the cube h the depth of an orifice of area of cross-section A, below the liquid surface. The velocity of the liquid flowing through the orifice is

a) $\sqrt{2gh}$ b) $\sqrt{2gh}\sqrt{\left(\frac{A^2}{A^2-a^2}\right)}$ c) $\sqrt{2gh}\sqrt{\left(\frac{A}{A-a}\right)}$ d) $\sqrt{2gh}\sqrt{\left(\frac{A^2-a^2}{A^2}\right)}$

364. A metal plate of area $10^3\,cm^2$ rests on a layer of oil 6 mm thick. A tangential force of $10^{-2}\,N$ is applied on it to move it with a constant velocity of $6\,cms^{-1}$. The coefficient of viscosity of the liquid is

a) 0.1 poise b) 0.5 poise c) 0.7 poise d) 0.9 poise

365. The level of water in a tank is 5 m high. A hole of area $10\,cm^2$ is made in the bottom of the tank. The rate of leakage of water from the hole is

a) $10^{-2}\,m^3 s^{-1}$ b) $10^2\,m^3 s^{-1}$ c) $10\,m^3 s^{-1}$ d) $10^{-2}\,m^{-3} s^{-1}$

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

a) $2v$ b) v c) $v/2$ d) $4v$

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

a) No change

b) It will rise

c) It will fall

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

368. What is velocity v of a metallic ball of radius r falling in a tank of liquid at the instant when its acceleration is one-half that of the freely falling body?

(The densities of metal and of liquid are ρ and σ respectively, and the viscosity of the liquid is η)

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

369. A mercury drop of radius 1 cm is broken into 10^6 droplets of equal size. The work done is $(S=35\times 10^{-2}\,N m^{-1})$

a) 4.35×10^{-2} J b) 4.35×10^{-3} J c) 4.35×10^{-6} J d) 4.35×10^{-8} J

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

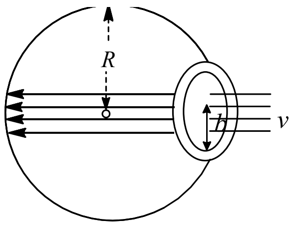
a) Acceleration due to gravity b) Height of the liquid column

c) Area of the bottom surface d) Nature of the liquid

371. A metal ball immersed in alcohol weighs W_1 at $0\,°C$ and W_2 at $59\,°C$. The coefficient of cubical of cubical expansion of the metal is less than that of alcohol. Assuming that the density of the metal is large compared to that of alcohol, it can be shown that

a) $W_1 > W_2$ b) $W_1 < W_2$ c) $W_1 = W_2$ d) $W_1 = 2W_2$

372. A streamline body with relative density ρ_1 falls into air from a height h_1 on the surface of a liquid of relative density ρ_2, where $\rho_2 > \rho_1$. The time of immersion of the body into the liquid will be



a) $\sqrt{2h_1/g}$ b) $\sqrt{2h_1/g} \times \frac{\rho_1}{\rho_2}$ c) $\sqrt{\frac{2h_1}{g}} \times \frac{\rho_1}{\rho_2}$ d) $\sqrt{\frac{2h_1}{g}} \times \frac{\rho_1}{(\rho¿¿2-\rho_1)¿}$

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

a) 3/2 b) 6 c) 2 d) 3

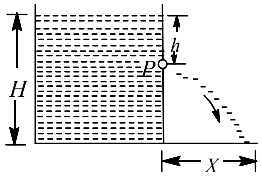
374. In a turbulent flow, the velocity of the liquid in contact with the walls of the tube is

a) Zero
b) maximum
c) in between zero and maximum
d) equal to critical velocity

375. Two solid spheres of same metal but of mass M and $8M$ fall simultaneously on a viscous liquid and their terminal velocities are v and nv, then value of n is

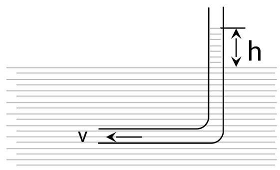
a) 16 b) 8 c) 4 d) 2

376. A tank is filled with water upto a height H. Water is allowed to come out of a hole P in one of the walls at a depth h below the surface of water (see figure). Express the horizontal distance X in terms of H and h



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

377. An L-shaped glass tube is just immersed in flowing water such that its opening is pointing against flowing water. If the speed of water current is v, then

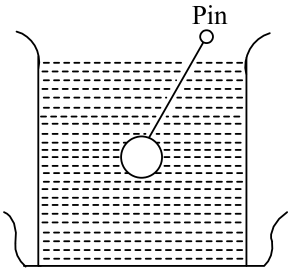


a) The water in the tube rises to height $\frac{v^2}{2g}$
b) The water in the tube rises to height $\frac{g}{2v^2}$
c) The water in the tube does not rise at all
d) None of these

378. With the increase in temperature, the angle of contact

a) Decreases
b) Increases
c) Remains constant
d) Sometimes increases and sometimes decreases

379. A vessel with water is placed on a weighing pan and it reads $0.8\, gcc^{-1}$ is sunk into the water with a pin of negligible volume as shown in figure keeping it sunk. The weighing pan will show a reading



a) 600 g b) 632 g c) 642 g d) 640 g

380. Typical silt(hard mud) particle of radius $20\,\mu m$ is on the top of lake water, its density is $2000\,kg\,m^{-3}$ and the viscosity of lake water is 1.0 mPa, density is $1000\,kg\,m^{-3}$. If the lake is still(has no internal fluid motion). The terminal speed with which the particle hits the bottom of the lake is ………. mms^{-1}

a) 0.67 b) 0.77 c) 0..87 d) 0.97

381. The pressure inside two soap bubble is 1.01 and 1.02 atm respectively. The ratio of their respective volume is

a) 2 b) 4 c) 6 d) 8

382. At a given place where acceleration due to gravity is $g\,ms^{-2}$, a sphere of lead of density $d\,k\,gm^{-3}$is gently released in a column of liquid of density $\rho\,kg\,m^{-3}$. If $d>\rho$, the sphere will

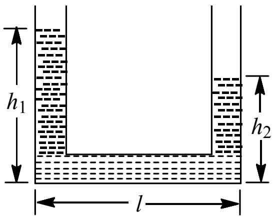
a) Fall vertically with an acceleration $g\,ms^{-2}$

b) Fall vertically with no acceleration

c) Fall vertically with an acceleration $g\left(\frac{d-\rho}{d}\right)$

d) Fall vertically with an acceleration $g\left(\frac{\rho}{d}\right)$

383. A liquid of density ρ is filled in a U-tube is accelerated with an acceleration a so that the height of liquid in its two vertical arms are h_1 andh_2 as shown in the figure. If l is the length of horizontal arm of the tube, the acceleration a is



a) $\frac{g(h_1-h_2)}{2l}$ towards right

b) $\frac{g(h_1-h_2)}{2l}$ towards left

c) $\frac{g(h_1-h_2)}{l}$ towards right

d) $\frac{g(h_1-h_2)}{l}$ towards left

384. Spherical ball 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

a) directly proportional to$R$ but inversely proportional to$v$

b) directly proportional to both radius$R$ and velocity v

c) inversely proportional to both radius$R$ and velocity$v$

d) inversely proportional to$R$ but directly proportional to velocity v

385. An aeroplane gets its upward lift due to phenomenon described by the

a) Archimedes' principle

b) Bernoulli's principle

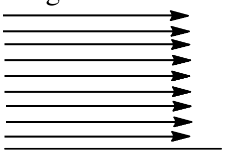
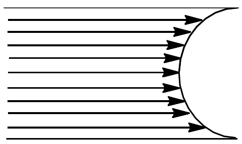
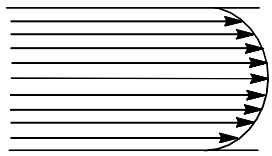
c) Buoyancy principle

d) Pascal law

386. 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

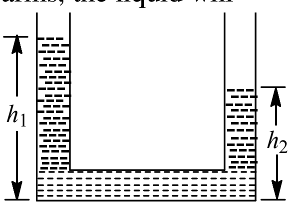
387. Calculate the force of attraction between two parallel plates separated by a distance 0.2 mm after a water drop of mass 80 mg is introduced between them. The wetting is assumed to be complete. (Surface tension of water is $0.07\,N\,m^{-1}$)
a) 0.14 N
b) 0.28 N
c) 0.42 N
d) 0.56 N

388. A viscous fluid is flowing through a cylindrical tube. The velocity distribution of the fluid is best represented by the diagram
a) 
b) 
c) 
d) None of these

389. If there were no gravity, which of the following will not be there for fluid?
a) Viscosity
b) Surface tension
c) Pressure
d) Archimedes' upward thrust

390. A hole is made at the bottom of the tank filled with water (density 1000 kg/m^3). If the total pressure at the bottom of tank is 3 atm (1 atm = $10^5\,N/m^2$), then the velocity of efflux is
a) $\sqrt{200}$ m/s
b) $\sqrt{400}$ m/s
c) $\sqrt{500}$ m/s
d) $\sqrt{800}$ m/s

391. The U-tube has a uniform cross-section as shown in figure. A liquid is filled in the two arms upto heights h_1 and h_2 and then the liquid is allowed to move. Neglect viscosity and surface tension. When the level equalize in the two arms, the liquid will



a) Be at rest
b) Be moving with an acceleration of $g\left(\frac{h_1-h_2}{h_1+h_2+2}\right)$
c) Be moving with a velocity of $(h_1-h_2)\sqrt{\frac{g}{2(h_1+h_2+2)}}$
d) Exert a net force to the right on the cube

392. A water drop of $0.05\,cm^3$ is squeezed between two glass plates and spreads into area of $40\,cm^2$. If the surface tension of water is $70\,dyne\,cm^{-1}$ then the normal force required to separate the glass plates from each other will be
a) 22.5 N
b) 45 N
c) 90 N
d) 450 N

393. A bigger drop of radius R is converted into n smaller drops of radius r, the required energy is
a) $(4\pi r^2 n - 4\pi R^2)T$
b) $\left(\frac{4}{3}\pi r^2 n - \frac{4}{3}\pi R^3\right)T$
c) $(4\pi R^2 - 4\pi r^2)nT$
d) $(n4\pi r^2 - n4\pi R^2)T$

394. Two capillary tubes of radii 0.2 cm and 0.4 cm are dipped in the same liquid. The ratio of heights through which liquid will rise in the tubes is
a) 1 : 2
b) 2 : 1
c) 1 : 4
d) 4 : 1

395. The flow of liquid is laminar or steam line is determined by

a) rate of flow of liquid
b) density of fluid
c) radius of the tube
d) coefficient of viscosity of liquid

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

a) $152 cm$
b) $76 cm$
c) $38 cm$
d) $38\sqrt{3} cm$

397. A film of water is found between two straight parallel wires of length 10 cm each separated by 0.2 cm. If their separation is increased by 1 mm, while still maintaining their parallelism, how much work will have to be done? (surface tension of water is $7.2 \times 10^{-2} N m^{-1}$)

a) 7.22×10^{-6} J
b) 1.44×10^{-5} J
c) 2.88×10^{-5} J
d) 5.76×10^{-5} J

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

a) H
b) $2H$
c) $7H$
d) $8H$

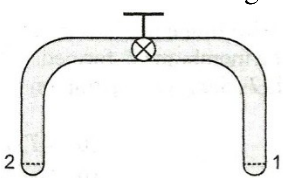
399. A soap bubble A radius 0.03 and another bubble B of radius 0.04 m are brought together so that the combined bubble has a common interface of radius r, then the value of r is

a) 0.24 m
b) 0.48 m
c) 0.12 m
d) None of these

400. Two rain drops of same radii $'r'$, falling with terminal velocity $'v'$ merge and form a bigger drops of radius R. The terminal velocity of the bigger drop is

a) $v\frac{R}{r}$
b) $v\frac{R^2}{r^2}$
c) v
d) $2v$

401. 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 increases

402. The rate of flow of water in a capillary tube of length l and radius r is V. The rate of flow in another capillary tube of length $2l$ and radius $2r$ for same pressure difference would be

a) $16V$
b) $9V$
c) $8V$
d) $2V$

403. A horizontal pipe of cross-sectional diameter 5 cm carries water at velocity of $4 ms^{-1}$. The pipe is connected to a smaller pipe with a cross-sectional diameter 4 cm. the velocity of water through the smaller pipe is

a) $6.25 ms^{-1}$
b) $5.0 ms^{-1}$
c) $3.2 ms^{-1}$
d) $2.56 ms^{-1}$

404. Two soap bubbles A and B are kept in a closed chamber where the air is maintained at pressure 8 Nm^{-2}. The radii of bubbles is $0.04 Nm^{-1}$. Find the ratio $\frac{n_B}{n_A}$, where n_A and n_B are the number of moles of air in bubbles A and B, respectively. [Neglect the effect of gravity]

a) 4
b) 6
c) 7
d) 8

405. A body floats in water with one-third of its volume above the surface of water. If it is placed in oil, it floats with half of its volume above the surface of the oil. The specific gravity of the oil is

a) $\frac{5}{3}$ b) $\frac{4}{3}$ c) $\frac{3}{2}$ d) 1

406. The total weight of a piece of wood is 6 kg. In the floating state in water its $\frac{1}{3}$ part remains inside the water. On this floating solid, what maximum weight is to be put such that the whole of the piece of wood is to be drowned in the water?>

a) 12 kg b) 10 kg c) 14 kg d) 15 kg

407. The water flows from a tap of diameter $1.25\,cm$ with a rate of $5\times10^{-5} m^3 s^{-1}$. The density and coefficient of viscosity of water are $10^3\,kg\,m^{-3}$ and 10^{-3} Pas, respectively. The flow of water is

a) Steady with Reynolds number 5100
b) Turbulent with Reynolds number 5100
c) Steady with Reynolds number 3900
d) Turbulent with Reynolds number 3900

408. Two liquid drops have diameters of 1 cm and 1.5 cm. The ratio of excess of pressure inside them is

a) 1:1 b) 5:3 c) 2:3 d) 3:2

409. A soap film is made by dipping a circular frame of radius b in soap solution. A bubble is formed by blowing air with speed v in the form of cylinder. The radius of the bubble formed $R \gg b$ so that the air is incident normally on the surface of bubble. Air stops after striking surface of soap bubble. Density of air is ρ. The radius R of the bubble when the soap bubble separates from the ring is (surface tension of liquid is S)

a) $\frac{S}{\rho v^2}$ b) $\frac{4S}{\rho v^2}$ c) $\frac{Sb}{\rho v}$ d) $\frac{4Sb}{\rho v^2}$

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

a) $V/4$ b) $16V$ c) $V/8$ d) $V/32$

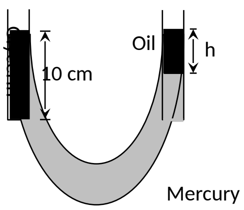
411. The working of an atomizer depends upon

a) Bernoulli's theorem
b) Boyle's law
c) Archimedes principle
d) Newton's law of motion

412. A fluid flows through a horizontal pipe having two different cross-sections of area A and$2A$. If the pressure at the thin cross-section is p and fluid velocity is v, the velocity and pressure at the thicker cross-section is (take the density of fluid as ρ)

a) $\frac{v}{2}, p+\frac{1}{2}\rho v^2$ b) $\frac{v}{4}, p+\frac{3}{8}\rho v^2$ c) $\frac{v}{2}, p+\frac{3}{8}\rho v^2$ d) $v, p+\frac{3}{4}\rho v^2$

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



a) $10.4\,cm$ b) $8.2\,cm$ c) $7.2\,cm$ d) $9.6\,cm$

414. A cylindrical vessel of height $500\,mm$ has an orifice (small hole) at its bottom. The orifice is initially closed and water is filled in it up height H. Now the top is completely sealed with a cap and the orifice at the bottom is opened. Some water comes out from the orifice and the water level in the vessel becomes steady with height of water column being $200\,mm$. Find the fall in height (in mm) of water level due to opening of the orifice (Take atmospheric pressure ¿ $1.0\times10^5\,N/m^2$, density of water ¿ $1000\,kg/m^3$ and $g=10\,m/s^2$. Neglect any effect

of surface tension)

a) $5\,mm$ b) $6\,mm$ c) $2\,mm$ d) $1\,mm$

415. Why the dam of water reservoir is thick at the bottom

a) Quantity of water increases with depth
b) Density of water increases with depth
c) Pressure of water increases with depth
d) Temperature of water increases with depth

: ANSWER KEY :

1)	a	2)	c	3)	c	4)	d	169)	c	170)	d	171)	c	172)	c
5)	a	6)	b	7)	c	8)	c	173)	d	174)	a	175)	b	176)	b
9)	b	10)	d	11)	b	12)	b	177)	c	178)	d	179)	d	180)	a
13)	b	14)	b	15)	c	16)	c	181)	a	182)	a	183)	b	184)	b
17)	b	18)	c	19)	a	20)	d	185)	d	186)	d	187)	b	188)	c
21)	b	22)	c	23)	b	24)	b	189)	a	190)	a	191)	c	192)	d
25)	d	26)	a	27)	c	28)	a	193)	d	194)	d	195)	b	196)	b
29)	c	30)	a	31)	b	32)	d	197)	b	198)	b	199)	c	200)	d
33)	d	34)	b	35)	d	36)	a	201)	b	202)	a	203)	d	204)	b
37)	c	38)	c	39)	b	40)	d	205)	d	206)	d	207)	d	208)	d
41)	d	42)	d	43)	a	44)	d	209)	d	210)	a	211)	d	212)	d
45)	d	46)	c	47)	d	48)	c	213)	c	214)	b	215)	b	216)	d
49)	d	50)	b	51)	c	52)	c	217)	d	218)	c	219)	c	220)	a
53)	c	54)	b	55)	b	56)	b	221)	a	222)	c	223)	c	224)	c
57)	a	58)	c	59)	a	60)	c	225)	d	226)	b	227)	a	228)	c
61)	b	62)	b	63)	c	64)	b	229)	a	230)	b	231)	b	232)	a
65)	d	66)	c	67)	b	68)	b	233)	a	234)	c	235)	c	236)	c
69)	b	70)	c	71)	a	72)	d	237)	b	238)	c	239)	b	240)	b
73)	c	74)	d	75)	b	76)	b	241)	a	242)	d	243)	d	244)	d
77)	c	78)	c	79)	b	80)	d	245)	d	246)	c	247)	b	248)	d
81)	c	82)	b	83)	c	84)	d	249)	c	250)	d	251)	c	252)	a
85)	c	86)	a	87)	d	88)	a	253)	c	254)	c	255)	c	256)	a
89)	d	90)	c	91)	b	92)	b	257)	b	258)	d	259)	c	260)	c
93)	c	94)	c	95)	c	96)	c	261)	d	262)	d	263)	b	264)	a
97)	b	98)	c	99)	d	100)	c	265)	d	266)	d	267)	a	268)	c
101)	d	102)	c	103)	a	104)	d	269)	c	270)	b	271)	b	272)	b
105)	d	106)	c	107)	c	108)	c	273)	a	274)	d	275)	d	276)	c
109)	a	110)	b	111)	a	112)	d	277)	c	278)	b	279)	b	280)	d
113)	d	114)	a	115)	c	116)	c	281)	b	282)	b	283)	d	284)	a
117)	b	118)	d	119)	a	120)	c	285)	d	286)	b	287)	b	288)	a
121)	b	122)	d	123)	a	124)	c	289)	c	290)	c	291)	c	292)	b
125)	a	126)	a	127)	d	128)	b	293)	d	294)	c	295)	b	296)	b
129)	a	130)	d	131)	c	132)	c	297)	c	298)	c	299)	a	300)	b
133)	d	134)	a	135)	b	136)	d	301)	a	302)	c	303)	c	304)	a
137)	c	138)	d	139)	c	140)	a	305)	c	306)	a	307)	a	308)	c
141)	c	142)	a	143)	d	144)	b	309)	a	310)	b	311)	c	312)	a
145)	b	146)	b	147)	d	148)	a	313)	d	314)	c	315)	c	316)	a
149)	d	150)	d	151)	a	152)	d	317)	a	318)	c	319)	d	320)	d
153)	a	154)	a	155)	c	156)	a	321)	b	322)	a	323)	a	324)	a
157)	a	158)	b	159)	c	160)	c	325)	b	326)	a	327)	a	328)	b
161)	c	162)	a	163)	a	164)	d	329)	b	330)	b	331)	c	332)	b
165)	c	166)	d	167)	c	168)	a	333)	a	334)	d	335)	a	336)	b

337)	**a**	**338)**	**b**	**339)**	**a**	**340)**	**c**
341)	**b**	**342)**	**c**	**343)**	**c**	**344)**	**d**
345)	**d**	**346)**	**b**	**347)**	**a**	**348)**	**c**
349)	**c**	**350)**	**b**	**351)**	**a**	**352)**	**b**
353)	**d**	**354)**	**a**	**355)**	**c**	**356)**	**d**
357)	**a**	**358)**	**c**	**359)**	**c**	**360)**	**d**
361)	**b**	**362)**	**a**	**363)**	**b**	**364)**	**a**
365)	**a**	**366)**	**d**	**367)**	**a**	**368)**	**a**
369)	**a**	**370)**	**c**	**371)**	**b**	**372)**	**d**
373)	**d**	**374)**	**d**	**375)**	**c**	**376)**	**c**
377)	**a**	**378)**	**a**	**379)**	**d**	**380)**	**c**
381)	**a**	**382)**	**c**	**383)**	**c**	**384)**	**b**
385)	**b**	**386)**	**a**	**387)**	**b**	**388)**	**c**
389)	**d**	**390)**	**b**	**391)**	**c**	**392)**	**b**
393)	**a**	**394)**	**b**	**395)**	**a**	**396)**	**a**
397)	**b**	**398)**	**c**	**399)**	**c**	**400)**	**b**
401)	**b**	**402)**	**c**	**403)**	**a**	**404)**	**b**
405)	**b**	**406)**	**a**	**407)**	**b**	**408)**	**d**
409)	**b**	**410)**	**d**	**411)**	**a**	**412)**	**c**
413)	**d**	**414)**	**b**	**415)**	**c**		

: HINTS AND SOLUTIONS :

1 **(a)**
Upthrust is independent of all factors of the body such as its mass, size, density etc, except the volume of the body inside the fluid. Fraction of volume immersed in the liquid $V_{¿}=\left(\frac{\rho}{\sigma}\right)V\ ie,$ it depends upon the densities of the block and liquid. So, there will be no change in it if system moves upward or downward with constant velocity or some acceleration. Therefore, the upthrrust on the body due to liquid is equal tto the weight of the body in air.

3 **(c)**
When terminal velocity v is reaching, then

$$F=2\times10^{-5}v=\frac{4}{3}\pi r^3\rho g$$

$$2\times10^{-5}v=\frac{4}{3}\times\frac{22}{7}\times(1.5\times10^{-3})^3\times10^3\times10$$

On solving, $v=7.07\,m\,s^{-1}\approx7\,m\,s^{-1}$

4 **(d)**
Since, weight of bag with water is equal to the weight of water displaced, hence reading of spring balance is zero

5 **(a)**

$$F=6\pi\eta r v$$

$$¿6\times3.14\times(18\times10^{-5})\times0.03\times100$$

$$¿101.73\times10^{-4}\,dyne$$

6 **(b)**
If A_0 in the area orifice at the bottom below the free surface and A that of vessel, then time t taken to be emptied the tank is given as

$$t=\frac{A}{A_0}\sqrt{\frac{2H}{g}}$$

$$\therefore\frac{t_1}{t_2}=\sqrt{\frac{H_1}{H_2}}$$

$$\Longrightarrow\frac{t}{t_2}=\sqrt{\frac{H_1}{H_1/2}}$$

$$\Longrightarrow\frac{t}{t_2}=\sqrt{2}$$

$$\therefore t_2=\frac{t}{\sqrt{2}}=\frac{10}{\sqrt{2}}$$

$$¿5\sqrt{2}=7\,min$$

7 **(c)**
According to Bernoulli's Theorem; $p=\frac{1}{2}\rho v^2$ =constant. Near the ends, the velocity of liquid is higher so that pressure is lower as a result the liquid rises at the sides to compensate for this drop of pressure

$$ie,\rho g h=\frac{1}{2}\rho v^2=\frac{1}{2}\rho r^2\omega^2$$

Hence, $h=\frac{r^2\omega^2}{2g}=\frac{r^2(2\pi v)^2}{2g}=\frac{2\pi^2r^2v^2}{g}$

$$¿\frac{2\times\pi^2\times(0.05)^2\times2^2}{9.8}$$

$$¿0.02\,m=2\,cm$$

8 **(c)**
Depth of p below the free surface of water in the vessel$¿(1+h)$. Since the liquid exerts equal pressure in all direction at one level, hence the pressure at $p=(H-h)\rho g$

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

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

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

Where, $\Delta p=p-p_0=h\rho_0 g$
= pressure difference between depth and surface of ocean

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

12 **(b)**

Since density of iron is more than that of marble, the volume of iron is less than that of marble for the given mass. The up thrust of water on iron will be less than that on marble. Due to which iron cube will weigh more

13 **(b)**

For an incompressible liquid equation of continuity $Av = constant$

¿ $A \propto \frac{1}{v}$

therefore, at the wider end speed will be low and at narrow end speed will be high.

15 **(c)**

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

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

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

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

16 **(c)**

Terminal velocity of the ball through a viscous medium

$v = \frac{2}{9} \times \frac{g}{\eta}(\rho - \sigma)r^2$

$v = \frac{2}{9} \times \frac{g}{\eta}(\rho)r^2$

because viscous medium of negligible density $(\sigma = 0)$

$v = \frac{2}{9} \times \frac{g}{\eta} \times \frac{m}{\frac{4}{3}\pi r^3} \times r^2 \left(\therefore e = \frac{m}{\frac{4}{3}\pi r^3}\right)$

¿ $v = \frac{2}{9} \times \frac{g}{\eta} \times \frac{m}{\frac{4}{3}\pi r^3}$

$\Longrightarrow v = \frac{1}{r}$

For the second ball

$v \propto \frac{1}{2r}$

Because radius of second ball is twice that of the first ball

$\frac{v}{v} = \frac{2r}{r} \vee v' = \frac{v}{2}$

17 **(b)**

$\frac{dv}{dx} = \frac{8}{0.1} = 80\,s^{-1}$

18 **(c)**

Here, mass of block, $m = 1\,kg$

Volume of a block, $V = 3.6 \times 10^{-4}\,m^3$

Tension in the string, $T = mg = mg - V\rho_{water}\,g$

$\therefore$ Decrease in the tension of string ¿ $T - T$

¿ $mg - [mg - V\rho_{water}\,g] = V\rho_{water}\,g$

¿ $(3.6 \times 10^{-4}\,m^3) \times (10^3\,kg\,m^{-3}) \times (10\,m\,s^{-2}) = 3.6\,N$

20 **(d)**

We know that surface tension is related to work as $W = T \times \Delta A$

Since, surface area of sphere is

$4\pi R^2$ and there are two free surfaces, we have

$W = T \times 8R^2 \ldots\ldots(i)$

¿ $volume\ of\ sphere = \frac{4}{3}\pi R^3$

$ie, V = \frac{4}{3}\pi R^3$

$\Longrightarrow R = \left(\frac{3V}{4\pi}\right)^{1/3} \ldots\ldots(ii)$

From Eqs. (i) and (ii), we get

$W = T \times 8\pi \times \left(\frac{3V}{4\pi}\right)^{2/3}$

$\Longrightarrow W \propto V^{2/3}$

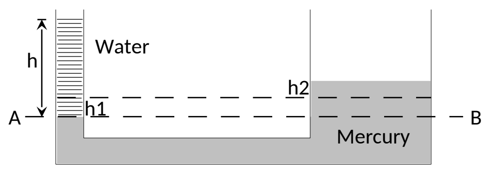
$\therefore W_1 \propto V_2^{2/3}$

¿ $W_2 \propto V_2^{2/3}$

$\frac{W_2}{W_1} = \left(\frac{2V_1}{V_1}\right)^{2/3}$

$\Longrightarrow W_2 = 2^{2/3}W_1 = 4^{1/3}W$

21 **(b)**



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

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

Now, pressure at point $A =$ ¿ pressure at point B

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

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

22 **(c)**

Velocity of ball when it strikes the water surface

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

Terminal velocity of ball inside the water

$v = \frac{2}{9} r^2 g \left(\frac{\rho - 1}{\eta}\right)$ ...(ii)

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

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

23 **(b)**

As solid is floating in liquid, so weight of solid body = weight of liquid displaced by immersed part of the body $ie, VD\,g = v\,d\,g$

Or $v/V = D/d$

25 **(d)**

Let V be the the volume of the brass block weight of brass block ¿ $V\rho_B g$

Weight of brass block when immersed in liquid ¿ $V\rho_B g - V\rho_L g$. If A is the area of cross-section of steel wire, then

$Y = \frac{V\rho_B g}{A} \times \frac{L}{l} = \frac{(V\rho_B g - V\rho_L g)}{A} \times \frac{L}{l'}$

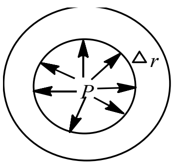
Or $\frac{l}{l'} = \frac{\rho_B}{\rho_B - \rho_L}$

26 **(a)**

The excess pressure inside a liquid drop is

$\Delta p = \frac{2T}{r}$

¿ $\Delta p \propto \frac{T}{r}$



The excess pressure inside a liquid drop is directly proportional to surface tension (T) and inversely proportional to radius (r).

27 **(c)**

As the both points are at the surface of liquid and these points are in the open atmosphere. So both point possess similar pressure and equal to $1\,atm$. Hence the pressure difference will be zero

28 **(a)**

Total pressure (p)= atmospheric pressure (p_0) + pressure due to water column in tank (p')

$\therefore p' = p - p_0 = 3 - 1 = 2$ atmosphere

Or $h \times 10^3 \times 10 = 2 \times 10^5$ or $h = 20$ m

$v = \sqrt{2gh} = \sqrt{2 \times 10 \times 20} = \sqrt{400}\,m\,s^{-1}$

29 **(c)**

$Time\,taken\,t = \sqrt{\frac{2h}{g}}$

Time taken for the level of water to fall from h to $h/2$

$t_1 = \sqrt{\frac{2}{g}}\left[\sqrt{h_1} - \sqrt{h_2}\right] = \sqrt{\frac{2}{g}}\left[\sqrt{h} - \sqrt{\frac{h}{2}}\right]$

¿ $\sqrt{\frac{2h}{g}}\left(1 - \frac{1}{\sqrt{2}}\right)$

Similarly, time taken for the level of water to fall from $h/2$ to 0.

$t_2 = \sqrt{\frac{2}{g}}\left[\sqrt{\frac{h}{2}} - 0\right]$

$\Longrightarrow t_2 = \sqrt{\frac{2h}{g}} \cdot \frac{1}{\sqrt{2}}$

$\therefore \frac{t_1}{t_2} = \frac{\sqrt{\frac{2h}{g}}\left(1 - \frac{1}{\sqrt{2}}\right)}{\sqrt{\frac{2h}{g}}\frac{1}{\sqrt{2}}}$

¿ $\frac{\left(\frac{\sqrt{2}-1}{\sqrt{2}}\right)}{1/\sqrt{2}} = \sqrt{2} - 1$

30 **(a)**

Apparent weight ¿ $V(\rho - \sigma)g$

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

31 **(b)**

The net force on the tank

$F = 2A\rho g h$

Where $A = area\ of\ cross-section\ of\ the\ hole$

$\rho =$ ¿ density of water

$h =$ ¿vertical distance between the holes

$\therefore\ F = 2 \times 0.01 \times 1000 \times 10 \times 1 = 200\,N$

32 **(d)**

$Shearing\ stress = \eta\left(\frac{dv}{dx}\right)$

$= 10^{-3}\left(\frac{10}{20}\right)=0.5\times 10^{-3}\,Nm^{-2}$

33 **(d)**

If we have m gram of ice which is a floating in a liquid of density 1.2 and 9 L will displaces volume $\frac{m_{cc}}{1.2}<m_{cc}$. After melting it occupics m_{cc}.

35 **(d)**

According to equation of continuity $av=¿$ constant.

As v increases, a decreases

36 **(a)**

Terminal velocity, $v=\frac{2r^2(\rho-\rho_0)g}{9\eta}$

$ie, v\propto r^2$

$\therefore \frac{v_1}{v}=\frac{r_1^2}{r^2}$

Or $v_1=v\left(\frac{r_1}{r}\right)^2$

$¿20\left(\frac{1}{2}\right)^2=5\,cm\,s^{-1}$

37 **(c)**

For the floatation $V_0 d_0 g=V_¿ d\,g \Rightarrow V_¿=V_0\frac{d_0}{d}$

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

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

38 **(c)**

Level of water will remain unchanged.

39 **(b)**

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

40 **(d)**

Let $M_0=¿$ mass of body in vacuum

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

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

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

41 **(d)**

The height (h) to which water rises in a capillary tube is given by

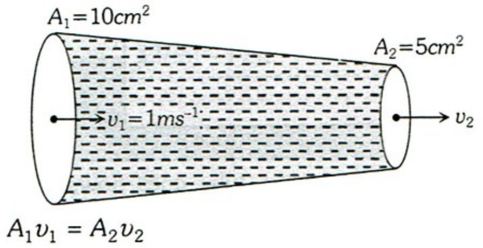
$h=\frac{2T\cos\theta}{r\rho g}$

where θ is angle of contact , r the radius, ρ the density and g acceleration due to gravity.

When lift moves down with constant acceleration, height is less than h, because effective value of acceleration due to gravity increases hence h decreases.

42 **(d)**

According to equation of continuity



$$\therefore v_2=\frac{A_1v_1}{A_2}=\frac{10\,cm^2\times 1\,m\,s^{-1}}{5\,cm^2}=2\,m\,s^{-1}$$

For a horizontal pipe, according to Bernoulli's theorem

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

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

¿ $2000+\frac{1}{2}\times 10^3\times\left(1^2-2^2\right)$

[$\because$ Density of water, $\rho=10^3\,kg/m^3$]

¿ $2000-\frac{1}{2}\times 10^3\times 3=2000-1500=500\,Pa$

43 **(a)**

Terminal velocity $v\propto r^2$

¿ $\frac{v^1}{v^2}=\left(\frac{r_1}{r_2}\right)^2=\left[\left(\frac{r_1}{r_2}\right)^3\right]^{\frac{2}{3}}$

$$\frac{v_1}{v_2}=\left(\frac{M_1}{M_2}\right)^{2/3}$$

$$\frac{0.5}{v_2}=\left(\frac{20\times 10^{-3}}{54\times 10^{-2}}\right)^{2/3}$$

$$\frac{0.5}{v_2}=\frac{1}{9}\qquad\Rightarrow\qquad v_2=4.5\,ms^{-1}$$

44 **(d)**

When we move from centre to circumference, the velocity of liquid goes on decreasing and finally becomes zero

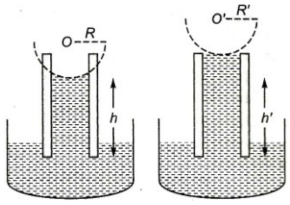
45 **(d)**

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

46 **(c)**

If the length of the tube h' is less than h, is found that the liquid dose not overflow. In a tube of insufficient length, the liquid rises upto the top of the tube and increases the radius of curvature, of its mentiscus to a value R ,so that

$$R'h'=Rh$$



ie, smaller the length (h') of the tube, greater will be the radius of curvature (R') of the meniscus, but the liquid will never overflow.

47 **(d)**

As, $\frac{4}{3}\pi R^3=1000\times\frac{4}{3}\pi r^3$

$R=10r$

Surface energy of small drop $E_1=S\times 4\pi r^2$

Surface energy of large drop $E_2=S\times 4\pi(10r)^2$

$E_1/E_2=1/100$

48 **(c)**

Surface energy $U=S\times 2\times 4\pi R^2$

(As there are 2 surfaces in soap bubble)

$U=4.5\times 10^{-2}\times 8\pi\times\left(2.1\times 10^{-2}\right)^2$

¿ $4.93\times 10^{-4}\,J$

49 **(d)**

Given, $l_1=l_2=1$, and $\frac{r_1}{r_2}=\frac{1}{2}$

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

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

50 **(b)**

Impact speed

¿ $\sqrt{2gh}=\sqrt{2\times 9.8\times 1200}=153.3\times\frac{18}{5}\approx 550\,km/h$

51 **(c)**

Weight of wax in air,

$W_a=18.03\,g$

Weight of metal piece in water¿ $17.03\,g$

Weight of metal piece and wax in water ¿ $15.23\,g$

Weight of wax in water

$W_w=15.23-17.03=-1.8\,g$

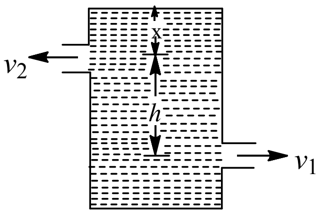
Therefore, specific gravity of wax

$¿\frac{weigth\ of\ wax \in air}{weight\ of\ wax \in air - weight\ of\ wax \in water}$

$¿\frac{18.03}{18.03-(-1.8)}=\frac{18.03}{19.83}$

52 **(c)**

Here, $v_1=\sqrt{2g(h+x)};v_2=\sqrt{2gx}$



Let a= area of cross-section of each hole

$\rho=¿$ density of the liquid

The momentum of the liquid flowing out per second through lower hole ¿ mass× velocity

$¿a v_1 \rho \times v_1 = a\rho v_1^2$

The force exerted on the lower hole towards left

$¿a\rho v_1^2$

Similarly, the force exerted on the upper hole towards right $¿a\rho v_2^2$

Net force on the tank, $F=a\rho(v_1^2-v_2^2)$

$¿a\rho[2g(h+x)-2gx]=2a\rho g h$

$ie, F \propto h$

53 **(c)**

The excess pressure inside the soap bubble is inversely proportional to radius of soap bubble $ie, p \propto 1/r, r$ being radius of soap bubble. If follows that pressure inside a smaller bubble is greater than that inside a bigger bubble. Thus, if these two bubbles are connected by a tube, air will flow from smaller bubble grows at the expense of the smaller one.

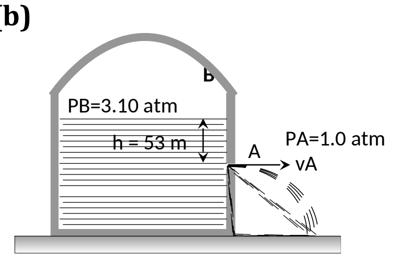
54 **(b)**

In case of soap bubble

$W=T\times 2\times \Delta A$

$¿0.03\times 2\times 40\times 10^{-4}=2.4\times 10^{-4}J$

55 **(b)**



According to Bernoulli's theorem

$P_B+h\rho g=P_A+\frac{1}{2}\rho v_A^2[As\ v_A>¿v_B]$

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

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

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

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

56 **(b)**

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

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

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

57 **(a)**

When a highly soluble salt (like sodium chloride) is dissolved in water, the surface tension of water increases

58 **(c)**

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

59 **(a)**

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

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

When body (sphere) is fully immersed then,

Upthrust $¿wt.$ of sphere + wt. of water poured in sphere

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

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

60 **(c)**

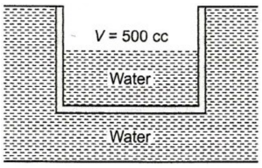
Figure 3 is stream lined, so air resistance of it will be minimum. For figure 1 surface area is maximum, so air resistance for it is maximum. Hence, correct sequence is

3<2<1.

61 **(b)**

From Archimedes' principle weight of water displaced is equal to weight of stone. The level will fall because when the large stone was in the boat, volume of water displaced is equal to volume of large stone. But when the stone is dropped in the lake, it displaces volume of water equal to its volume which is less than in the previous case.

62 **(b)**
As the flask floats in water in less than half filled with water, it will float just fully submerged when half filled. In the situation,
mass of flask +mass of water in it¿ $V\sigma$



$ie, 390+250=V\times 1\,(as\,\sigma=1\,g\,cc^{-1})$
ie, outer of volume of flask
$V=640\,cc$
Now, as inner volume of flask is given to be 500 cc, so the volume of the material of flask
¿ $640-500=140\,cc$. But as mass of flask is 390 g, so density of material of flask
$\rho=\frac{m}{v}=\frac{390}{140}=2.8\,g\,cc^{-1}$

63 **(c)**
Volume of liquid flowing at first point ¿ $A_1 v_1$.
Similarly, volume of liquid flowing at second point
¿ $A_2 v_2$
From equation of continuity,
$A_1 v_1=A_2 v_2$
¿ $\frac{v_1}{v_2}=\frac{A_2}{A_1}$

64 **(b)**
The volume of liquid displaced by floating ice
$V_D=\frac{M}{\sigma_L}$
Volume of water formed by melting ice, $V_F=\frac{M}{\sigma_W}$
If $\sigma_L>\sigma_W$, then $\frac{M}{\sigma_L}<\frac{M}{\sigma_W}\, i.e. V_D<V_F$
$i.e.$ volume of liquid displaced by floating ice will be lesser than water formed and so the level if liquid will rise

65 **(d)**
Terminal velocity of single drop,
$v=3.75\,cms^{-1}=3.75\times 10^{-2}\,ms^{-1}$
Terminal velocity of the big drop
$V=n^{\frac{2}{3}}v$
¿ $(8)^{2/3}\times 3.75\times 10^{-2}$
¿ $4\times 3.75\times 10^{-2}=15\times 10^{-2}\,ms^{-1}$

66 **(c)**
Soap solution has lower surface tension, T as compared to pure water and capillary rise
$h=\frac{2T\cos\theta}{\rho r g}$, so h is less for soap solution.

67 **(b)**
l Will decreases because the block moves up. h will decreases because the coin will displace the volume (V_1) of water equal to its own volume when it is in water whereas when it is on the block it will displace the volume of water (V_2) whose weight is equal to weight of coin and science density of coin is greater than the density of water,
$\therefore V_1<V_2$

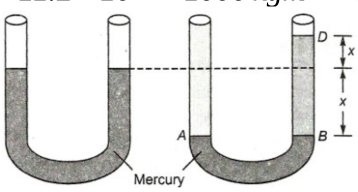
68 **(b)**
$\rho_{oil}<\rho<\rho_{water}$
Oil is the least dense of them so it should settle at the top with water at the base. Now the ball is denser than oil but less denser than water. So, it will sink through oil but will not sink in water. So it will stay at the oil-water interface.

69 **(b)**
When two drops are splitted, the law of conservation of mass is obeyed

70 **(c)**
On pourring water on left side, mercury rises x cm (say) from its previous level in the right limb of U-tube crating a differences of levels of mercury by $2x$ cm. Equating pressure at A and B, we get
$p_A=p_B$

$\therefore\ 11.2\times 10^{-2}\times \rho_{water}\times g=2x\times \rho_{Hg}\times g$

$11.2\times 10^{-2}\times 1000\,kgm^{-3}=2x\times 13600\,kgm^{-3}$



$x=\frac{11.2\times 10^{-2}\times 1000}{2\times 13600}\,m=0.41\,cm$

71 **(a)**
Bernoulli's equation for flowing liquid be written as

$p+\frac{1}{2}\rho v^2+\rho g h=constant$ ...(i)

Dividing the Eq. (i)by ρg, we have

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

In this expression, $\frac{v^2}{2g}$ is velocity head and $\frac{P}{\rho g}$ is pressure head.

It is given that,

$Velocity\, head=pressure\, head$

$ie, \frac{v^2}{2g}=\frac{P}{\rho g}$

¿ $v^2=\frac{2p}{\rho}$

¿ $=\frac{2\times 13.6\times 10^3\times 40\times 10^{-2}\times 9.8}{10^3}$

$\therefore v=10.32\, ms^{-1}$

72 **(d)**

$Gauge\, pressure=\frac{4T}{R}=\frac{4\times 0.03}{\frac{30}{20}\times 10^{-3}}=8\, Pa$

73 **(c)**

Gravitational force remains constant on the falling spherical ball. It is represented by straight line P. The viscous force $(F=6\pi\eta rv)$ increases as the velocity increases with time. Hence, it is represented by curve Q. Net force = gravitational force − viscous force. As viscous force increases, net force decreases and finally becomes zero. Then the body falls with a constant terminal velocity. It is thus represented by curve R

74 **(d)**

Apparent weight in air = $W-$¿ upthrust ¿ $V\rho g-V\sigma g$

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

75 **(b)**

Bernoulli's theorem for unit mass of liquid

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

As the liquid starts flowing , it pressure energy decreases

$\frac{1}{2}v^2=\frac{P_1-P_2}{\rho}$

$\Longrightarrow \frac{1}{2}v^2=\frac{3.5\times 10^5-3\times 10^5}{10^3}$

$\Longrightarrow v^2=\frac{2\times 0.5\times 10^5}{10^3}$

$\Longrightarrow v^2=100$

$\Longrightarrow v=10\, ms^{-1}$

76 **(b)**

Let the volume of the ball be V. Force on the hall due to upthrust $=Vdg$

Net upward force = $Vdg=VDg$

If upward acceleration is a, then

$Vda=Vdg-VDg$

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

Velocity on reaching the surface, $v=\sqrt{2ah}$

Further $v=\sqrt{2ah}$

$\therefore 2ah=2gH$

or $H=\frac{ah}{8}=\left(\frac{d-D}{D}\right)h=\left(\frac{d}{D}-1\right)h$

77 **(c)**

$V=\frac{\pi p r^4}{8\eta l}$ and $V'=\frac{\pi(3p+p)(r/2)^4}{8\eta l}$

$\therefore \frac{V'}{V}=4\times(1/2)^4=\frac{1}{4}$ or $V'=\frac{V}{4}$

78 **(c)**

Let $p_0=$¿ atmospheric pressure. Then

$p_1V_1=p_2V_2$ or $p_2=p_1\frac{V_1}{V_2}$

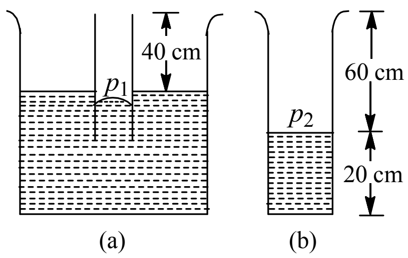
or $p_2=p_0\left(\frac{40}{60}\right)=\frac{2}{3}p_0$

$p_2+(20\, cm\, of\, Hg)=p_0$

or $\frac{2}{3}p_0+(20\, cm\, of\, Hg)=p_0$

or $\frac{p_0}{3}=20\, cm\, of\, Hg$

$p_0=60\, cm\, of\, Hg$



79 **(b)**

$M=\frac{4}{3}\pi r^3\rho$ and $8M=\frac{4}{3}\pi R^3\rho$

So $R^3=8r^3$

So $R=2r$; Now $v \propto r^2$ so,

$$\frac{v_1}{v}=\left(\frac{2r}{r}\right)^2=4 \text{ or } v_1=4v$$

80 **(d)**

For water-glass interface, the angle of contact is less than $90°$, so the shape of liquid meniscus is concave upward on both faces

81 **(c)**

If two drops of same radius r coalesce then radius of new drop is given by R

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

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

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

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

82 **(b)**

Kinetic head ¿ $v^2/2g$ and pressure head ¿ $p/\rho g$

83 **(c)**

Excess of pressure inside the bubble, $p=4S/r$. So smaller is the radius$r$, the larger is the excess of pressure$p$. It means, the pressure of air is more in bubble A than in bubble$B$. So the air will go from bubble A to bubble B

84 **(d)**

$a_1 v_1=a_2 v_2$

$\Longrightarrow 4.20 \times 5.18=7.60 \times v_2$

$\Longrightarrow v_2=2.86\, ms^{-1}$

85 **(c)**

Here, $\eta=10^{-3}\, N m^{-2} s, v=5 m s^{-1}; l=10 m$

Strain rate ¿ $\frac{v}{l}$

Coefficient of viscosity, $\eta=\frac{Shearing\, stress}{Strainrate}$

$\therefore$ Shearing stress ¿ $\eta \times$ Strain rate

¿ $\frac{(10^{-3} N m^{-2} s)(5 m s^{-1})}{(10 m)}=0.5 \times 10^{-3} N m^{-2}$

87 **(d)**

Mass of adulterated milk

$M_A=1032 \times 10 \times 10^{-3}$

¿ $10.32\, kg$

Mass of pure milk $M_p=1080 V_p$

$\therefore Mass\ of\ water\ \rho_w V_w=M_A-M_p$

$\Longrightarrow 10^3(10 \times 10^{-3}-V_p)=10.32-1080 V_p$

$\Longrightarrow 10-10^3 V_p=10.32-1080 V_p$

$\Longrightarrow 80 V_p=0.32$

$\therefore V_p=\frac{0.32}{80} m^3$

¿ $\frac{0.32}{80} \times 1000\, L=4\, L$

90 **(c)**

Effective weight of solid of specific gravity 1 when immersed in water will be zero

91 **(b)**

When a ball is given anticlockwise rotation along with linear motion towards RHS then it will have maximum flight

92 **(b)**

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

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

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

93 **(c)**

Pressure differences between lungs of students and atmosphere

¿ $(760-750)\, mm\ of\ Hg$

$ie,\ \ h\rho g=10\, mm\ of\ Hg=1\, cm\ of\ Hg$

or $h \times 1=1 \times 13.6$

$\therefore\ h=13.6\, cm$

94 **(c)**

Let D_1 be the inner diameter of the hemispherical bowl and D_2 be the outer diameter of the bowl. As bowl is just floating so

$\frac{4}{3}\pi\left(\frac{1}{2}\right)^3 \times 1.2 \times 10^3$

¿ $\frac{4}{3}\pi\left[\left(\frac{1}{2}\right)^3-\left(\frac{D_1}{2}\right)^3\right] \times (2 \times 10^4)$

Or $\frac{1.2 \times 10^3}{2 \times 10^4}=1-D_1^3$

Or $D_1=\left(1-\frac{1.2}{20}\right)^{1/3}=\left(\frac{18.8}{20}\right)^{1/3}$

On solving, $D_1=0.98$ m

95 **(c)**

If V is the volume of sphere and ρ is its density then

$V\rho=(V/2) \times 0.8+(V/2) \times 13.6$

¿ $7.2 V$

Or $\rho=7.2\, gc\, c^{-1}$

96 **(c)**

Movement of spinning ball, carburetor of automobile, heart attack and dynamic lift of an aeroplane all are based on the Bernoulli's principle

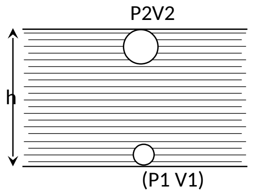
97 **(b)**

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

$\Rightarrow P_1 V_1 = P_2 V_2$

$\Rightarrow (P_0 + h\rho_w g) V_1 = P_0 V_2$

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



$\Rightarrow V_2 = \left(1 + \frac{47.6 \times 10^2 \times 1 \times 1000}{70 \times 13.6 \times 1000}\right) V_1$

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

[As $P_2 = P_0 = 70\, cm$ of $Hg = 70 \times 13.6 \times 1000$¿

98 **(c)**

The surface tension of liquid decreases with increases of temperature. For small temperature differences it decreases almost linearly. The surface tension of a liquid becomes zero at a particular temperature, called the critical temperature of that liquid.

100 **(c)**

Excess pressure inside a soap bubble of radius R is

¿ $\frac{4T}{R} \ldots\ldots (i)$

Where T is surface tension of liquid film.

Pressure due to oil column

¿ $h\rho g \ldots\ldots (ii)$

Where h is height of column, ρ the density and g the gravity.

From Eqs. (i) and (ii), we get

$\frac{4T}{R} = h\rho g$

$\Longrightarrow T = \frac{h\rho g R}{4}$

$Given, h = 2mm = 0.2\, cm, g = 980\, cms^{-2},$

$\rho = 0.8\, gcc^{-1}, R = 1\, cm$

$\therefore T = \frac{0.2 \times 0.8 \times 980}{4}$

¿ $3.92 \times 10\, dyne\, cm^{-1}$

¿ Nm^{-1}

$T = 3.9 \times 10 \times \frac{10^{-5}}{10^{-2}} = 3.9 \times 10^{-2} Nm^{-1}$

102 **(c)**

Relative density of solid

¿ $\frac{weight \in air}{weight \in air - weight \in water}$

$\Rightarrow$ Relative density of solid ¿ $\frac{120}{120-80} = \frac{120}{40} = 3$

Relative density of liquid

¿ $\frac{weight \in air - weight \in liquid}{weight \in air - weight \in water}$

$\Rightarrow$ Relative density of liquid

¿ $\frac{120-60}{120-80} = \frac{60}{40} = \frac{3}{2}$

103 **(a)**

In hydraulic life, the pressure of smaller piston = pressure of bigger piston ¿ F/A

¿ $(3000 \times 9.8)/(4.25 \times 10^{-2})$

¿ $6.92 \times 10^5\, N m^{-2}$

104 **(d)**

Surface tension of a liquid is due to force of attraction between like molecules of a liquid *ie* cohesive force between the molecules

105 **(d)**

Poiseuille's formula gives the quantity of liquid flowing

Through a capillary, $Q = \frac{\pi}{8} \frac{pr^4}{\eta l} \Rightarrow p = \frac{8}{\pi} Q . \frac{\eta l}{r^4}$

If $Q' = \frac{Q}{2}, r' = 2r$

$\frac{p'}{n} = \frac{8}{\pi} \frac{Q}{2} \frac{\eta l}{(2r)^4} = \frac{8}{\pi} \frac{Q . \eta l}{r^4} \times \frac{1}{32}$

$i.e.,$ pressure $p' = \frac{p}{32}$

106 **(c)**

Weight of block

= Weight of displaced oil + Weight of displaced water

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

$\Rightarrow m = (10 \times 10 \times 6) \times 0.6 + (10 \times 10 \times 4) \times 1 = 760\, gr$

107 **(c)**

For the given angular velocity of rotation, the centrifugal force $F \propto r$; therefore, more liquid will be accumulated near the wall of tube and the liquid meniscus will become concave upwards

108 **(c)**

Apparent weight = true weight − upward thrust

$$¿ w-\left(\frac{w}{\rho}\right)\rho_1=w\left(1-\frac{\rho_1}{\rho}\right)$$

109 **(a)**

$$\frac{dk}{dt}=\frac{d}{dt}\left(\frac{1}{2}Mv^2\right)=\frac{v^2}{2}.\frac{dM}{dt}=\frac{v^2}{2}\left(\frac{dM}{dl}\times\frac{dl}{dt}\right)$$

$$\Rightarrow\frac{dk}{dt}=\frac{1}{2}mv^2\times\frac{dl}{dt}=\frac{1}{2}mv^3$$

110 **(b)**

Let v be the volume of ice-berg outside the sea water while floating. Therefore, volume of ice-berg inside the sea water$¿(V-v)$. As ice-berg is floating, so weight of ice-berg = weight of sea water displaced by ice-berg

$ie\, V\times 0.9\times g=(V-v)\times 1.1\times g$

Or $1.1v=1.1V-0.9V$

Or $v/V=0.2/1.1=2/11$

111 **(a)**

The height of water in the tank becomes maximum when the volume of water flowing into the tank per second becomes equal to the volume flowing out per second. Volume of water flowing out per second

$¿ Av=A\sqrt{2gh}$ …(i)

Volume of water flowing in per second

$¿ 70\,cm^3/sec$ …(ii)

From (i) and (ii) we get

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

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

112 **(d)**

Pull on the rope = effective weight

$¿[1650+(1500\times 0.2)-1500\times 1.3]\,kgf$

$¿ 1650+300-1950$

$¿ 0$

113 **(d)**

From $V=\frac{P\pi r^4}{8\eta l}\Rightarrow P=\frac{V 8\eta l}{\pi r^4}$

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

$$\Rightarrow P_2=\frac{P_1}{4}=\frac{P}{4}$$

115 **(c)**

Let R be the radius of the biggest aluminium coin which will be supported on the surface of water due to surface tension. Then, $mg=S\times 2\pi R$

or $\pi R^2 t\rho g=S\times 2\pi R$

Or $R=2S/\rho g t$

116 **(c)**

Since the wire frame is dipped in liquid, therefore its membrane has two free surfaces. Total length of square wire frame in contact of membrane

$¿ 2\times perimeter\ of\ square=2\times 4L=8L$

Hence, force acting on a frame

$F=Tl=T\times 8L=8L$

117 **(b)**

Letd_w and d_0 be the densities of water and oil, then the pressure at the bottom of the tank

$¿ h_w d_w g+h_0 d_0 g$

Let this pressure be equivalent to pressure due to water of height h then

$h d_w g=h_w d_w g+h_0 d_0 g$

$$\therefore h=h_w+\frac{h_0 d_0}{d_w}$$

$$¿ 100+\frac{400\times 0.9}{1}$$

$¿ 100+360=460$

According to Toricelli's theorem,

$v=\sqrt{2gh}=\sqrt{2\times 980\times 460}$

$¿\sqrt{920\times 980}\,cm\,s^{-1}$

118 **(d)**

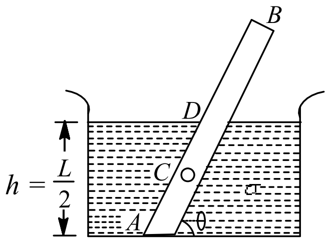
Water fills the tube entirely in gravity less condition.

119 **(a)**

$$AB=L, AC=\frac{L}{2}; AD=l(say)$$

Let A = area of cross-section of the rod

Weight of the rod $¿ AL\rho g$ acting vertically downwards at C



Upthrust of liquid on rod ¿ $Al\sigma g$, acting upwards through the mid-point of AD

For rotational equilibrium of rod net torque about point A should be zero. So

$$(LA\rho g)\frac{L}{2}\cos\theta=(lA\sigma g)\frac{l}{2}\cos\theta \vee \frac{l^2}{L^2}=\frac{\rho}{\sigma}$$

Or $\sin\theta=\frac{1}{2}\sqrt{\frac{\sigma}{\rho}}$

120 **(c)**

The air pressure inside a soap bubble is

$$p=\frac{4T}{R}$$

Which is greater than the atmospheric pressure. If a hole is made at A, air will flow outside through A. then the thread becomes convex looking from A and from B towards A it is concave. Hence, becoming concave or convex, depends on size of A with respect to B.

122 **(d)**

Here, $R=2.8/2=1.4\,mm=0.14\,cm$

¿ $\frac{4}{3}\pi R^3=125\times\frac{4}{3}\pi r^3$

Or $r=R/5=0.14/5=0.028$cm

Change in energy = surface tension × increase in area

¿ $75\times(125\times 4\pi r^2-4\pi R^2)$

¿ $74\,erg$

123 **(a)**

Volume of water in the vessel of base area A' and height h is $V=A'h$. Average velocity of out flowing water when height of water changes from h to 0 is

$$v=\frac{\sqrt{2gh}+0}{2}=\frac{\sqrt{2gh}}{2}$$

$\therefore V=Avt$ …(i)

When vessel is filled to height 4 h, then volume in vessel

¿ $4V=4Avt=4A\frac{\sqrt{2gh}}{2}\times t$

If t is the time taken for the out flowing liquid and v_1 is the average velocity of out flowing liquid then

$4V=Av_1t_1$

or $t_1=\frac{4V}{Av_1}=\frac{4A\sqrt{2gh}\times t\times 2}{2\times A\times\sqrt{2g\times 4h}}=2t$

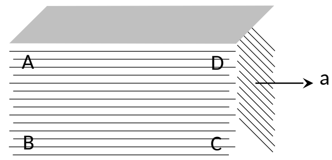
124 **(c)**

According to equation of continuity

$A_1V_1=A_2V_2+A_3V_3$

$\Rightarrow 4\times 0.2=2\times 0.2+0.4\times V_3 \Rightarrow V_3=1\,m/s$

125 **(a)**



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

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

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

126 **(a)**

When substances are mixed in equal volume then density

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

When substances are mixed in equal masses the density

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

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

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

127 **(d)**

Given that surface tension $=0.075\,N\,m^{-1}$;

diameter $=30\,cm=0.30\,m$

$\therefore$ *Force* $=0.075\times 0.30$

¿ $0.0225\,N=2.25\times 10^{-2}\,N$

128 **(b)**

The air pushed down by the wings of the parrot while flying will go out of the wire cage. Due to which the weight of wire cage will decreases

130 **(d)**

A liquid does not wet the solid surface if the angle of contact is obtuse *ie*, greater than $90°$. In this case cohesive forces will be greater than adhesive forces and so, the liquid does not wet the surface of solid.

131 **(c)**

The effective weight of the block in liquid will become less than 2 kg due to buoyancy of liquid. As a result of which A will read less than 2 kg

As the body immersed in liquid has some effective weight acting downwards so the reading of B will be more than 5 kg

132 **(c)**

Surface area, $A=4\pi r^2$ or $r=(A/4\pi)^{1/2}$

Volume $V=\frac{4}{3}\pi r^3$

Or ¿ $\frac{4}{3}\pi(A/4\pi)^{3/2}=kA^{3/2}$

Where $\frac{4\pi}{3}\times\frac{1}{(4\pi)^{3/2}}=k=$¿ constant

Using Boyle's law, we have

$p_1V_1=p_2V_2$

Or $p_2=\frac{p_1V_1}{V_2}=\frac{(10+h)kA_1^{3/2}}{kA_2^{3/2}}$

Or $p_2=(10+h)\left(\frac{A_1}{A_2}\right)^{3/2}$

¿ $(10+h)\left(\frac{1}{4}\right)^{3/2}=\frac{10+h}{8}$

As $p_2=10$ m of water, so

$10=\frac{10+h}{8}$ or $80=10+h$

Or $h=70$m

133 **(d)**

$h\rho g=\frac{2S}{r}$ or $h=\frac{2S}{r\rho g}$

¿ $\frac{2\times 75}{0.005\times 1\times 1000}=30\,cm$

134 **(a)**

If velocities of water at entry and exit points are v_1 and v_2, then according to equation of continuity

$A_1v_1=A_2v_2\Rightarrow\frac{v_1}{v_2}=\frac{A_2}{A_1}=\left(\frac{r_2}{r_1}\right)^2=\left(\frac{2}{3}\right)^2=\frac{4}{9}$

135 **(b)**

The velocity of ball before entering the water surface

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

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

The retardation,

$a=\frac{apparent\ weight}{mass\ of\ ball}$

$a=\frac{V(\rho-\sigma)g}{V\rho}=\frac{(\rho-\sigma)g}{\rho}$

$\left(\frac{0.4-1}{0.4}\right)g=\frac{-3}{2}g$

If h be the depth upto which ball sink, then

$0-v^2=2\times\left(\frac{-3}{2}g\right)\times h$

$\Longrightarrow 2g\times 9=3gh$

$\therefore h=6\,cm$

136 **(d)**

From the formula the viscous force is given by

$F=6\pi\eta rv$

¿ $6\times\frac{22}{7}\times 2\times 10^{-4}\times 0.35\times 10^{-3}\times 1$

¿ $13.2\times 10^{-7}\,N$

137 **(c)**

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

Where $m=$¿ mass of the body

$\rho=$¿ density of the body

$\sigma=$¿ density of water

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

$\therefore\frac{m_1}{\rho_1}(\rho_1-\sigma)=\frac{m_2}{\rho_2}(\rho_2-\sigma)\Rightarrow\frac{36}{9}(9-1)=\frac{48}{\rho_2}(\rho_2-1)$

By solving we get $\rho_2=3$

138 **(d)**

Let the volume of iceberg inside sea is x, then

$\frac{Volume\ of\ iceberg\ inside\ sea}{Total\ volume\ of\ iceberg}=\frac{Density\ of\ ice}{Density\ of\ sea\ wate}$

¿ $\frac{x}{V}=\frac{0.92}{1.03}$

$so\ x=\frac{0.92}{1.03}V$

Percentage of total volume of iceberg above the level of sea water is

¿ $\left(\frac{V-x}{V}\right)\times 100$

¿ $\left(\frac{V-\left(\frac{0.92}{1.03}\right)V}{V}\right)\times 100\%$

¿ $\frac{0.11}{1.03}\times 100\%=11\%(nearly)$

141 **(c)**

$$P_1 = P_2 \Rightarrow \frac{F_1}{A_1} = \frac{F_2}{A_2} \Rightarrow \frac{10^7}{10^2} = \frac{2000 \times 10^3 \times 10^3}{A_2}$$

$$\therefore A_2 = 2 \times 10^4\, cm^2 \left(g = 980 \approx 10^3\, cm/s^2\right)$$

142 **(a)**

Work done = surface tension × increase in area

¿ $72 \times [10 \times 0.7 - 10 \times 0.5] \times 2$

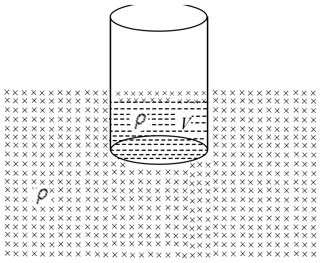
¿ 288 erg

143 **(d)**

$$mg + \rho \times V_l \times g = \frac{V_0}{2} \times \rho \times g$$

$$V_l = \frac{V_0}{2} - \frac{m}{\rho}$$

So $V_l < \frac{V_0}{2}$



145 **(b)**

Let P_0 is the atmospheric pressure, ρ the density of liquid and v the velocity at which water is coming out. Applying this Bernoulli's theorem just inside and outside the hole.

$$P_{inside} + \rho g h + 0 = P_{outside} + \frac{\rho v^2}{2}$$

$$\Longrightarrow P_0 + \rho g h = P_0 + \frac{\rho v^2}{2}$$

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

¿ $\sqrt{2 \times 10 \times 20}$

¿ $20\, ms^{-1}$

147 **(d)**

$$\frac{4S}{r_1} - \frac{4S}{r_2} = \frac{4S}{r}$$

Or $\frac{1}{r} = \frac{1}{r_1} - \frac{1}{r_2} = \frac{1}{4} - \frac{1}{5} = \frac{1}{20}$ or $r = 20$ cm

148 **(a)**

$$2\pi r \times T\cos\theta = \pi r^2 h \rho g$$

$$\Longrightarrow T = \frac{rh\rho g}{2} = 0.11\, Nm^{-1}$$

149 **(d)**

Angel of contact is defined as the angle inside the liquid between the tangent to the solid surface and the tangent to the liquid surface at the point contact. Hence, it depends on orientation of solid surface in liquid.

150 **(d)**

$$P = P_a + \rho g h$$

151 **(a)**

When a drop of radius R splits into n smaller drops, (each of radius r), then surface area of liquid increases and hence surface energy increases.

152 **(d)**

Excess of pressure, inside the first bubble $p_1 = \frac{4T}{r_1}$

$$Similarly,\, p_2 = \frac{4T}{r_2}$$

Let the radius of the large bubble be R. then, excess of pressure inside the large bubble $p = \frac{4T}{R}$

Under isothermal condition, temperature remains constant.

$$So,\, pV = p_1 V_1 + p_2 V_2$$

$$\frac{4T}{R}\left(\frac{4}{3}\pi r^3\right) = \frac{4T}{r_1}\left(\frac{4}{3}\pi r_1^3\right) + \frac{4T}{r_2}\left(\frac{4}{3}\pi r_2^3\right)$$

$$R^2 = r_1^2 + r_2^2$$

$$\Longrightarrow R = \sqrt{r_1^2 + r_2^2}$$

153 **(a)**

$$v_1 = \frac{V}{A_1} = \frac{12 \times 10^{-6}}{6 \times 10^{-6}} = 2\, m\, s^{-1} = 200\, cm\, s^{-1}$$

$$v_2 = \frac{V}{A_2} = \frac{12 \times 10^{-6}}{3 \times 10^{-6}} = 4\, m\, s^{-1} = 400\, cm\, s^{-1}$$

$$p_A - p_B = \rho g (h_2 - h_1) + \frac{\rho}{2}(v_2^2 - v_1^2)$$

¿ $1 \times 1000(100) + \frac{1}{2}(16 \times 10^4 - 4 \times 10^4)$

¿ $10^5 + 6 \times 10^4 = 1.6 \times 10^5\, dyne\, cm^{-2}$

154 **(a)**

Given, $v = \frac{2r^2 \rho g}{9\eta}$ …(i)

Mass ¿ $\frac{4}{3}\pi r^3 \rho = \frac{4}{3}\pi (2r)^3 \rho_1$

Or $\rho_1 = \rho/8$

Terminal velocity of second ball is

$$v_1 = \frac{2(2r)^2(\rho/8)g}{8\eta} = \frac{v}{2}$$

155 **(c)**

The speed of the body just before entering the liquid is$v=\sqrt{2gh}$. The buoyant force B of the lake ¿ upward thrust of liquid on the body) is greater than the weight of the body$w$, since$\sigma>\rho$. If V is the volume of the body and a is the acceleration of the body inside the liquid, then

$B-w=ma$

Or $\sigma V g-\rho V g=\rho V a$

Or $(\sigma-\rho)g=\rho a$ or $a=\frac{(\sigma-\rho)g}{\rho}$

Using the relation, $v^2=u^2+2as$, we have

$0=(\sqrt{2gh})^2-2g\frac{(\sigma-\rho)}{\rho}s$ or $s=\frac{h\rho}{\sigma-\rho}$

156 **(a)**

Surface tension (T)of a liquid is equal to the work (W) required to increases the surface area (ΔA) of the liquid film by unity at constant temperature.

$W=T\Delta A=surface\ energy$

Also, volume of big drop

¿$27\times volume\ of\ small\ drop$

$ie, V'=27V$

Where V' is volume of big drop of diameter D and V the volume of small drop of diameter d.

$\therefore \frac{4}{2}\pi\left(\frac{D}{2}\right)^3=27\times\frac{4}{3}\pi\left(\frac{d}{2}\right)^3$

$\Longrightarrow \frac{D}{2}=3\times\frac{d}{2}$

$\Longrightarrow d=\frac{D}{3}$

$Radius\ of\ small\ drop, r=\frac{d}{2}=\frac{D}{6}\cdot$

$\therefore Change \in surface\ energy=T(A_2-A_1)$

¿$T[27.4\pi r^2-4\pi R^2]$

¿$T4\pi\left[27\left(\frac{D}{6}\right)^2-\left(\frac{D}{6}\right)^2\right]$

¿$4\pi T\left[\frac{3D^2}{4}-\frac{D^2}{4}\right]=2\pi D^2 T$

157 **(a)**

When a body is falling in a liquid with a constant velocity, the viscous force acting upward is balanced by the effective weight of the body (ie gravity pull on the body) acting downwards

158 **(b)**

Let $V_1$and V_2 be the volumes, then

$V_1+V_2=V$

As ball is floating.

Weight of ball = upthrust on ball due to two liquids

$V\rho g=V_1\rho_1 g+V_2\rho_2 g$

$\Rightarrow V\rho=V_1\rho_1+(V-V_1)\rho_2$

$\Rightarrow V_1=\left(\frac{\rho-\rho_2}{\rho_1-\rho_2}\right)V$

Fraction in upper part ¿$\frac{V_1}{V}=\frac{\rho-\rho_2}{\rho_1-\rho_2}$

Fraction in lower part¿$1-\frac{V_1}{V}$

$1-\frac{\rho-\rho_2}{\rho_1-\rho_2}=\frac{\rho_1-\rho}{\rho_1-\rho_2}$

$\therefore$ Ratio of lower and upper parts ¿$\frac{\rho-\rho_2}{\rho_1-\rho}$

159 **(c)**

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

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

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

160 **(c)**

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

Or $p_1-p_2=\frac{1}{2}\rho(v_2^2-v_1^2)$

¿$\frac{1}{2}\times 1.3\times(120^2-90^2)$

¿$4.095\times 10^3\,N\,m^{-2}$

Gross lift on the wing ¿$(p_1-p_2)\times$ area

¿$4.095\times 10^3\times 10\times 2$

¿81.9×10^3 N

161 **(c)**

$\Delta p=\frac{2T}{r}=\frac{2\times 70\times 10^{-3}}{1\times 10^{-3}}=140\,Nm^{-2}$

163 **(a)**

When air is blown in the horizontal tube, the pressure of air decreases in the tube. Due to which the water will rise above the tube A

164 **(d)**

Volume of cylinder ¿ $\frac{m}{\rho}$

Upthrust on cylinder ¿ $\left(\frac{m}{\rho}\right)\sigma g$

From Newton's third law, the downward force exerted by cylinder on the liquid is ¿ $\left(\frac{m}{\rho}\right)\sigma g$

$\therefore$Increase in pressure ¿ $\frac{m\sigma g}{\rho A}$

165 **(c)**

The effective weight ¿ weight of bird + reactional force due to acceleration of bird

¿ $5+ma=5+0.5\times 2=6\,N$

166 **(d)**

$A=(0.1)^2=0.01\,m^2$,

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

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

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

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

168 **(a)**

Using theorem of continuity, we have

$\pi D_p^2 v_p=\pi D_Q^2 v_Q;$

$$v_p=\left(\frac{D_Q}{D_P}\right)^2 v_Q=\left(\frac{4\times 10^{-2}}{2\times 10^{-2}}\right)^2\times v_Q=v_Q=4\,v_Q$$

169 **(c)**

The angle θ, which the tangent to the liquid surface at the point of contact makes with the solid surface inside the liquid, is called the angle of contact or the capillary angle. The angle of contact is acute (less than $90°$) in the case of liquids which wet the walls of the container, then liquid rises in the capillary and angle of contact is obtuse (greater than $90°$) for the liquid which do not wet the walls of the container, *ie*, they fall in capillary tube.

170 **(d)**

$W=T\times 4\pi R^2$

$$\Longrightarrow \frac{W_1}{W_1}=\frac{T\times 4\pi R^2}{T\times 4\pi(3R)^2}$$

¿ $\frac{T\times 4\pi R^2}{T\times 36\pi R^2}=\frac{1}{9}$

$\therefore W_1:W_2=1:9$

171 **(c)**

$$t=\frac{A}{a}\sqrt{\frac{2}{g}}\left[\sqrt{H_1}-\sqrt{H_2}\right]$$

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

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

According to problem $T_1=T_2$

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

172 **(c)**

(i) FBD of the cube with respect to the container

$$B=\left(\frac{m}{\sigma}\right)\rho\,g_{eff}=m\left(\frac{\rho}{\sigma}\right)\sqrt{a^2+g^2}$$

$$\tan\theta=\frac{a}{g}$$

$$\sin\theta=\frac{a}{\sqrt{a^2+g^2}};\cos\theta=\frac{g}{\sqrt{a^2+g^2}}$$

Let acceleration of the cube w.r.t. container in horizontal direction in a_x'

$$mg+B\sin\theta-\frac{mg}{2}=ma_x$$

$$a_x=\frac{g}{2}+\frac{\rho}{\sigma}a=a_x\Rightarrow\frac{g}{2}+\frac{\rho}{\sigma}\cdot\frac{g}{2}=a_x$$

Hence, $a_x=a_x+\frac{g}{2}=g+\frac{g}{2}\frac{\rho}{\sigma}$

$$a_x=g\left[\frac{2\sigma+\rho}{2\sigma}\right]\quad\text{(i)}$$

In vertical direction: $B\cos\theta-mg=ma_y$

$$m\left(\frac{\rho}{\sigma}\right)\sqrt{a^2+g^2}\cdot\frac{g}{\sqrt{a^2+g^2}}-mg=ma_y$$

$$a_y=g\left[\frac{\rho}{\sigma}-1\right]=g\left[\frac{\rho-\sigma}{\sigma}\right]\quad\text{(ii)}$$

$$\frac{a_x}{a_y}=\frac{(2\sigma+\rho)}{2(\rho-\sigma)}$$

(ii) FBD of the sphere:

$a_x=g$

$$a_y=\frac{-mg+\frac{m\rho}{\sigma}g}{m}=\left(\frac{\rho-\sigma}{\sigma}\right)g$$

⇒ Hence, $\frac{a_x}{a_y}=\frac{\sigma}{\rho-\sigma}$

(iii) FBD of the cylinder

Hence, $(P_2-P_1)A=ma_x$

$$\frac{\rho\omega^2}{2}\left[(2x)^2-x^2\right]A=ma_x$$

$$\frac{\rho}{2}\left(\frac{2g}{3x}\right)3x^2A=(A-x)\sigma a_x$$

This gives $\frac{a_x}{g}=\frac{\rho}{\sigma}$

(iv) When the cart is not filled with liquid

$\tan\theta=\frac{a}{g}$ (i)

When the car is filled with liquid

FBD of the pendulum,

Cart: $(T+B)\sin\theta' mg$ (i)

$(T+B)\cos\theta'=mg$ (ii)

$\tan\theta'=\frac{a}{g}$ (iii)

Hence, $\frac{\tan\theta'}{\tan\theta}=\frac{1}{1}=\frac{\theta'}{\theta}=1:1$

173 **(d)**

As hole is made in the tank below the free surface of water, so water rushing from this hole follows a parabolic path.

The velocity of efflux liquid,

$v=\sqrt{2gh}$

$Time\,t=\sqrt{\frac{2(H-h)}{g}}$

Horizontal range, $R=vt$

$R=\left(2gh\times\frac{2(H-h)}{g}\right)^{\frac{1}{2}}$

$ie, R^2=4h(H-h)=4(Hh-h^2)$

The range is maximum if

$\frac{dR}{dh}=0$

¿ $\frac{2RdR}{dh}=4(H-2h)$

¿ $0=(H-2h)$

¿ $h=\frac{H}{2}$

174 **(a)**

Using Pascal's law

$$P_1=P_2\Rightarrow\frac{F_1}{\left(\frac{\pi d_1^2}{4}\right)}=\frac{F_2}{\left(\frac{\pi d_2^2}{4}\right)}\Rightarrow F_2=\frac{d_2^2}{d_1^2}F_1$$

175 **(b)**

Terminal velocity

$v_T=\frac{2}{9}\frac{r^2(\rho-\sigma)}{\eta}$

where $\rho=density\ of\ the\ ball$

$\sigma=density\ of\ liquid$

$r=radius\ of\ ball$

From this formula it is clear that terminal velocity is independent of height of liquid.

176 **(b)**

Pressure at bottom of the lake ¿ $P_0+h\rho g$

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

According to given condition

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

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

177 **(c)**

Terminal velocity

$v\propto r^2$

$\therefore\frac{v'}{v}=\frac{(2R)^2}{(R)^2}$

¿ $v'=4v$

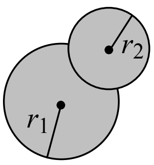
178 **(d)**

The excess of pressure inside the first bubble of radius r_1 is, $p_1=4S/r_1$; and in the second bubble of radius r_2 is, $p_2=4S/r_2$

$p=\frac{4S}{r}=\frac{4S}{r_1}-\frac{4S}{r_2}$

$\Rightarrow\frac{1}{r}=\frac{r_2-r_1}{r_1r_2}$

$\Rightarrow r=\frac{r_1r_2}{r_2-r_1}$



179 **(d)**

Tension in spring $T=$¿ upthrust – weight of sphere

¿ $V\sigma g-V\rho g=V\eta\rho g-V\rho g$ [As $\sigma=\eta\rho$ ¿

¿ $(\eta-1)V\rho g=(\eta-1)mg$

180 **(a)**

The liquid which do not wet the solid have obtuse angle of contact. For mercury and glass, the angle of contact is $135°$.

181 **(a)**

Let at a time tdV be the decrease in volume of water in vessel in time dt. Therefore rate of decreases of water in vessel = rate of water flowing out of narrow tube

So $-\frac{dV}{dt}-\frac{\pi(p_1-p_2)r^4}{8\eta l}$

But $p_1=p_2=h\rho g$

$\therefore-\frac{dV}{dt}=\frac{\pi(h\rho g)r^4}{8\eta l}=\frac{(\pi\rho g r^4)}{8\eta l\times A}\times(h\times A)$

Where $h\times A=$¿ Volume of water in vessel at a time $t=V$

$\therefore dV=-\left(\frac{\pi\rho g r^4}{8\eta lA}\right)\times V\,dt=-\lambda V\,dt$

Or $\frac{dV}{V}=-\lambda\,dt$

Where $\frac{\pi\rho g r^4}{8\eta lA}=\lambda=$¿ constant

Integrating it within the limits as time changes 0 to t, volume changes V_0 to V

Or $\log_e\frac{V}{V_0}=-\lambda t$ or $V=V_0e^{-\lambda t}$

Where $V_0=$¿ initial volume of water in vessel

¿ Ah_0

Therefore, $h\times A=h_0Ae^{-\lambda t}$ or $h=h_0e^{-\lambda t}$

Thus, the variation of h and t will be represented by exponential curve as given by (a)

182 **(a)**

Force on the ring due to surface tension of water

¿ $(\pi D_1+\pi D_2)S=mg$

So $S=\frac{mg}{\pi(D_1+D_2)}=\frac{3.47\times980}{(22/7)\times(8.5+8.7)}$

¿ $72.07\,dyne\,cm^{-1}$

183 **(b)**

$V=\frac{\pi Pr^4}{8\eta l}=\frac{8\,cm^3}{sec}$

For composite tube

$V_1=\frac{P\pi r^4}{8\eta\left(l+\frac{l}{2}\right)}=\frac{2}{3}\frac{\pi Pr^4}{8\eta l}=\frac{2}{3}\times8=\frac{16}{3}\frac{cm^3}{sec}$

$\left[\because l_1=l=2l_2\vee l_2=\frac{l}{2}\right]$

184 **(b)**

As the water level rises in one arm; it falls in another arm by 25 m. Equating the pressure at depth 50 cm down in arm of water with other due to liquid, we have $h\times0.8\times g=50\times1\times g$

Or $h=50/0.8=62.5$ cm

Height of oil in one limb above the water in another limb

¿ $62.5-50=12.5\,cm$

185 **(d)**

When the surface area of a liquid is increased, molecules from the interior of the liquid rise to surface. As these molecules reach the surface work is done against the cohesive force. This work is stored in the molecules in the form of potential energy. Thus, the potential energy of the molecules lying in the surface is greater than that of the molecules in the mirror of the liquid.

186 **(d)**

The terminal velocity of the spherical body of radius R, density ρ falling through a liquid of density σ is given by

$$v_T=\frac{2}{9}\frac{R^2(\rho-\sigma)g}{\eta}$$

Where η is the coefficient of viscosity of the liquid

$$\therefore v_{T_1}=\frac{2R_1^2(\sigma_2-\sigma)g}{9\eta} \text{ and } v_{T_2}=\frac{2R_2^2(\sigma_2-\sigma)g}{9\eta}$$

According to the given problem, $v_{T_1}=v_{T_2}$

$$R_1^2(\rho_1-\sigma)=R_2^2(\rho_2-\sigma) \text{ or } \frac{R_1^2}{R_2^2}=\frac{\rho_2-\sigma}{\rho_1-\sigma}$$

Substituting the given values, we get

$$\frac{R_1^2}{R_2^2}=\frac{(11\times10^3-2\times10^3)}{(8\times10^3-2\times10^3)}=\frac{9}{6}=\frac{3}{2}$$

$$\frac{R_1}{R_2}=\sqrt{\frac{3}{2}}$$

187 **(b)**

According to Bernoulli's theorem, $h=\frac{v^2}{2g}$

$$\Rightarrow h=\frac{(2.45)^2}{2\times10}=0.30\,m=30.0\,cm$$

$\therefore$ Height of jet coming from orifice

¿ $30.0-10.6=19.4\,cm\cong20\,cm$

188 **(c)**

Due to surface tension water rises in the capillary tube upto a height h with concave meniscus on both the sides. Therefore, the total height of water column in the capillary tube ¿ $h+h=2h$

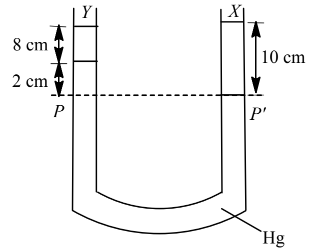
189 **(a)**

In level flight of aeroplane, $mg=pA$

Or $p=\frac{mg}{A}=\frac{3\times10^4\times10}{120}Pa=2.5\,kPa$

190 **(a)**

As shown in figure, in the two arms of a tube pressure remains same on surface *PP'*.



Hence, $8\times\rho_y\times g\times2\times\rho_{Hg}\times g=10\times\rho_x\times g$

$$\therefore 8\rho_y+2\times113.6=10\times3.36$$

or $\rho_y=\frac{36.6-27.2}{8}=0.8\,gcc^{-1}$

191 **(c)**

We have

$$v^2=\rho gh$$

$$a^2\sqrt{\rho gh}=\pi r^2\sqrt{\rho gh}\times2$$

$$r=\frac{a}{2\pi}$$

192 **(d)**

Reading of the spring balance

¿ Apparent weight of the block

= Actual weight – upthrust

¿ $12-V$ ¿ σg

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

193 **(d)**

Let b be width of the glass wall. When the tank is half filled then the average force on the glass wall is

$F=$ ¿ average pressure $\times$area

¿ $\left[\left(\frac{4}{2}\right)\rho_w g\right]\times\left[\frac{4}{2}\times b\right]$

When tank is filled up to height 4 m, then

$$F'=(4\rho_w g)(4\times b)$$

$$\frac{F'}{F}=\frac{4\times4}{2\times2}=4 \text{ or } F'=4F$$

194 **(d)**

Let R and R' be the radius of bubble of volume V and $2V$ respectively. Then

$$\frac{4}{3}\pi R^3=V \text{ and } \frac{4}{3}\pi R'^3=2V$$

So, $\frac{R'^3}{R^3}=2$ or $R'=(2)^{1/3}R$

As $W=S\times(4\pi R^2)2$ and $W'=S\times(4\pi R'^2)2$

$$\frac{W'}{W}=\frac{R'^2}{R^2}=2^{2/3}=(4)^{1/3} \text{ or } W'=(4)^{1/3}W$$

195 **(b)**

As excess pressure, $p \propto 1/r$, therefore, pressure inside C is highest and pressure inside B is lowest. The pressure inside A is in between. Therefore C starts collapsing with volume of A and B increasing

196 **(b)**

Given : $u=S\times 4\,p\,R^2$; when droplet is splitted into 1000 droplets each of radius r, then

$\frac{4}{3}\pi R^3=1000\times\frac{4}{3}\pi r^3$ or $r=R/10$

∴ Surface energy of all droplets

¿ $S\times 1000\times 4\pi r^2=S\times 1000\times 4\pi\,(R/10)^2$

¿ $10(S\,4\pi/R^2)=10u$

197 **(b)**

$V=\frac{\pi p r^4}{8\eta l}, ie, V\propto r^4$

$\frac{V'}{V}=\frac{(a/2)^4}{a^4}=\frac{1}{16}$ or $V'=\frac{V}{16}=\frac{16}{16}=1\,cm^3$

198 **(b)**

An oil drop spreads as thin layer, on the surface of water because the cohesive force between water molecules is greater than the adhesive force between water-oil molecules, hence the surface tension of water is greater than that oil.

199 **(c)**

The system is closed. The weight of parrot is suppresses the base of air cage with a weight equal to weight of parrot. These are internal forces. So there will be no change in the reading of the spring balance

200 **(d)**

The velocity gradient

¿ $\frac{\Delta V}{\Delta r}=\frac{8}{0.1}=80\,s^{-1}$

202 **(a)**

Rate of flow of liquid is given by

$\frac{dQ}{dt}=\frac{\pi p r^4}{8\eta L}$

As capillaries are joined ∈ series, so $\left(\frac{dQ}{dt}\right)$

will be same for each capillary.

Hence, $\frac{\pi p r^4}{8\eta L}=\pi p'$ ¿¿

So, pressure difference across the ends of 2nd capillary

$p'=8p$

and across the ends of 3rd capillary

$p'=27p$

203 **(d)**

Excess pressure inside a spherical drop of water

$p=\frac{2T}{R}$

Given, $p_1=4p_2$

$\frac{2T}{R_1}=4\times\frac{2T}{R_2}$

¿ $R_2=4R_1$

Now, $\frac{m_1}{m_2}=\frac{4\pi R_1^3 d_1}{4\pi R_2^3 d_2}$

¿ $\frac{m_1}{m_2}=\frac{R_1^3}{R_2^3}$

$\frac{m_1}{m_2}=\frac{1}{64}$

204 **(b)**

Change in surface energy ¿ 2×10^{-4} J

$\Delta A=10\times 6-8\times 3.75$

¿ $30\,cm^2$

¿ $30\times 10^{-4}\,m^2$

Work done $W=T\times 2\times$ (change in area)

Now, change in surface energy ¿ Work done

$2\times 10^{-4}=T\times 2\times 30\times 10^{-4}$

$T=3.3\times 10^{-2}\,N\,m^{-1}$

205 **(d)**

$2Sl=F$

Or $S=F/2l=(2\times 10^{-2})/2\times 0.10=0.1\,N\,m^{-1}$

207 **(d)**

If v is the terminal velocity, then

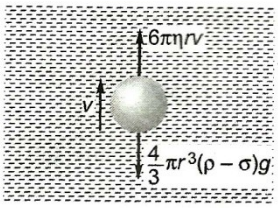
$xg-yg=6\pi\eta r v$

Or $v=\frac{(x-y)}{r}\frac{g}{6\pi\eta}$

Or $v\propto\frac{(x-y)}{r}$

208 **(d)**

Let a bubble of radius r and density ρ is rising up in a liquid whose density is σ and coefficient of viscosity η.



Then effective force acting downward

¿ $V(\rho-\sigma)g=\frac{4}{3}\pi r^3(\rho-\sigma)g$

Viscous force acting upward¿$6\pi\eta rv$.

Since bubble is moving up with constant velocity v, there is no acceleration in it, the net force acting on it must be zero.

$$\therefore 6\pi\eta rv=\frac{4}{3}\pi r^3(\rho-\sigma)g$$

$$\Longrightarrow \eta=\frac{2}{9}\frac{r^2(\rho-\sigma)}{v}g$$

$Given, v=-2\times10^{-3}ms^{-1}, r=10^{-2}m$

$\rho=0, \sigma=1.5\times10^3 kgm^{-3}, g=10^{-2}$

$\therefore \eta=2\times$ ¿¿

¿ $\frac{3}{18\times10^{-3}}=\frac{1}{6}\times10^3$

¿$0.167\times10^3=167\,units$.

209 **(d)**

$\rho_1<\rho_2$ as denser liquid acquires lowest position of vessel.

$\rho_3<\rho_2$ as ball sinks in liquid 1 and $\rho_3<\rho_2$ as ball doesn't sinks in liquid 2, so

$\rho_1<\rho_3<\rho_2$

210 **(a)**

Viscous force upwards = Apparent weight in liquid

$$\therefore Viscous\,force=Mg-\frac{Mgd_2}{d_1}$$

$$Viscous\,force=Mg\left(1-\frac{d_2}{d_1}\right)$$

211 **(d)**

When a tiny lead short is gently dropped on the surface of a viscous liquid, the velocity of lead shot will increase with time and finally will reach to a steady value called terminal velocity

212 **(d)**

Pressure applied by liquid column

$p=h\rho g$

Ie, the pressure depends on the height of liquid column no on its size, so pressure at the bottom of A and B is same.

213 **(c)**

Volume ¿ $\frac{4}{3}\pi R^3=8\times\frac{4}{3}\pi r^3$ or $r=R/2$

Work done ¿ $T\times(4\pi r^2\times8-4\pi R^2)$

¿ $T\times4\pi\left(\frac{R^2}{4}\times8-R^2\right)=4\pi R^2T$

214 **(b)**

Pressure at the bottom ¿hdg

Pressure at the top due to liquid column =0

$$\therefore Mean\,pressure=\frac{hdg+0}{2}=hdg/2$$

215 **(b)**

The rate of flow of water inside a capillary

$$V=\frac{\pi pr^4}{8nl},$$

$$Pressure\,difference\,p=\frac{V(8nl)}{\pi r^4}$$

In series combination $p=p_1+p_2$

where $p_1$and$p_2$are the pressure difference in the two tubes.

$$\therefore \frac{V(8nl)}{\pi r^4}=\frac{V'(8nl)}{\pi r^4}+\frac{V'(8nl)}{\pi(\pi/2)^4}$$

In series combination, rate of flow of water(V')will be same in both the tubes.

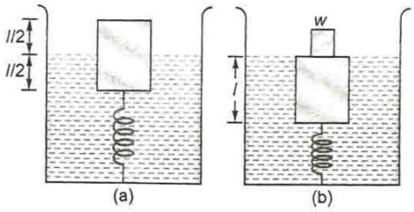
$$\frac{V}{r^4}=\frac{V'}{r^4}+\frac{V'\times16}{r^4}$$

$$V=V'+16V'$$

$$V'=\frac{V}{17}$$

216 **(d)**

Initially the position of wooden block is as shown in figure. Since, the density of block is half than that of water, hence half of its volume is immersed in water



When weight w is put on the block, the remaining half of the volume of block is immersed in water, figure (b). Therefore, $w=$¿additional upthrust + spring force

¿$l\times l\times\frac{1}{2}\times2\rho\times g+k\left(\frac{1}{2}\right)=l\left(l^2\rho g+\frac{k}{2}\right)$

217 **(d)**

$V(d-d_1)g=m_1g$

$V(d-d_2)g=m_2g$

$$\frac{d-d_1}{d-d_2}=\frac{m_1}{m_2}$$

$$\therefore d=\frac{m_1d_2-m_2d_1}{m_1-m_2}$$

218 **(c)**

The force of surface tension pulls the plates towards each other

219 **(c)**

For parallel combination $\frac{1}{R_{eff}}=\frac{1}{R_1}+\frac{1}{R_2}$

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

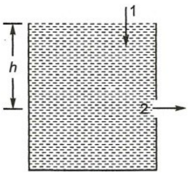
220 **(a)**

Applying continuity equation at1 and2, we have

$A_1 v_1 = A_2 v_{2.........(i)}$

Further applying Bernoulli's equation at these two points, we have

$p_0+\rho g h+\frac{1}{2}\rho v_1^2 = p_0+0+\frac{1}{2}\rho v_2^2 ......(ii)$



Solving Eqs. (i) and (ii) we have

$v_2^2=\frac{2gh}{1-\frac{A_2^2}{A_1^2}}$

Substituting the values, we have

$v_2^2=\frac{2\times 10\times 2.475}{1-(0.1)^2}=50\,m^2 s^{-2}$

221 **(a)**

Fraction of volume immersed in the liquid

V¿ $=\left(\frac{\rho}{\sigma}\right)V$

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

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

222 **(c)**

Form principle of continuity

$A_1 v_1 = A_2 v_2$

$\pi R^2 \cdot v = \pi (2R)^2 \cdot v_2$

$v_2 = \frac{v}{4}$

223 **(c)**

Let l be the length of the cylinder in water it is in the vertical position and A be the cross-sectional area of the cylinder. As cylinder is floating so

Weight of cylinder = upward thrust$mg=Al\rho g$ or $m=Al\rho$

When the cylinder is tilled through an angle θ, length of cylinder in water ¿ $\frac{l}{\cos\theta}$

Weight of water displaced ¿ $\frac{l}{\cos\theta}A\rho g$

Restoring force ¿ $\frac{lA\rho g}{\cos\theta}=lA\rho g$

¿ $lA\rho g\left[\frac{1}{\cos\theta}-1\right]=mg\left[\frac{1}{\cos\theta}-1\right]$

224 **(c)**

The surface tension of liquid decreases with rise of temperature. The surface tension of liquid is zero at its boiling point and it vanishes at critical temperature. At critical temperature intermolecular forces for liquid and gases becomes equal and liquid can expand without any restriction. For small temperature differences, the variation in surface tension with temperature is linear and is given by relation

$T_1=T_0(1-\alpha t)$

Where T_1, T_0 are the surface tension at t °C and 0 °C respectively and α is the temperature coefficient of surface tension.

225 **(d)**

$V\sigma f=0.6\,V\sigma_1 g$

$V\sigma g=0.4\,V\sigma_2 g$

$\therefore 1=\frac{6}{4}\frac{\sigma_1}{\sigma_2}$

$\therefore \frac{\sigma_2}{\sigma_1}=\frac{3}{2}=1.5$

226 **(b)**

Force on the base of the vessel

¿ pressure $\times$area of the base

¿ $h\rho g\times A=0.4\times 900\times 10\times 2\times 10^{-3}$

¿ 7.2 N

227 **(a)**

The surface tension of liquid at critical temperature is zero

228 **(c)**

In time Δt, momentum of water entering the hydrant

$\vec{p}_1=(\rho L\Delta t)v\hat{j}$

Momentum of water while leaving the hydrant in time Δt is $\vec{p}_2=(\rho L \Delta t) v(-\hat{i})$

Change in momentum in time Δt is

$\Delta \vec{p}=\vec{p}_2-\vec{p}_1=\rho L \Delta t v(-\hat{i}-\hat{j})$

$|\Delta \vec{p}|=\rho L \Delta t v \sqrt{(-1)^2+(-1)^2}$

$¿\sqrt{2}\rho L \Delta t v$

Force exerted by water, $F=¿\Delta \vec{p} \vee \frac{¿}{\Delta t}=\sqrt{2}\rho L v ¿$

229 **(a)**

According to Bernoulli's theorem when an in compressible and non-viscous (liquid) or gas flows in stream-lined motion from one place to another, then at every point of its path the total energy per unit volume (pressure energy + kinetic energy +potential energy) is a constant.

Hence, in stream line flow of liquid, the total energy of liquid is constant at all points.

230 **(b)**

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

Hence work done against air friction in the first $100\,m$ is less than the work done in next $100\,m$

231 **(b)**

Let A be the area of cross-section of through and ρ be the density of mercury

Initial mass of mercury in trough

$¿A\times 3.6\times \rho$

Final mass of mercury in trough

$¿A h' \rho=(A\times 3.6\times \rho)\times 2$

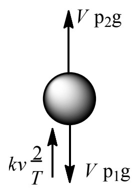
or $h'=7.2$ cm

232 **(a)**

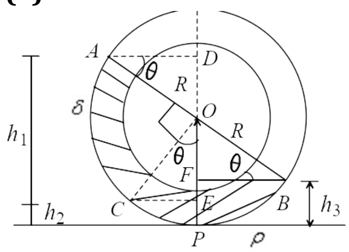
The force acting on the ball are gravity force, buoyancy force and viscous force. When ball acquires terminal speed, it is in dynamic equilibrium, let terminal speed of ball is v_T.

So, $V\rho_2 g+k v_T^2=V\rho_1 g$

$v_r=\sqrt{\frac{V(\rho_1-\rho_2)g}{k}}$



233 **(a)**



Vertical height of the liquid in portion AC

$h_1=DO+OE=R\sin\theta+R\cos\theta=R¿¿$

Vertical height of the liquid in portion CP

$h_2=R-R\cos\theta=R¿¿$

Vertical height of the liquid in portion PB

$h_3=R-R\sin\theta=R¿¿$

In equilibrium, the pressure due to liquid on the both sides must be equal at the lowest point P

$\delta g h_1+\rho g h_2=\rho g h_3$ [As pressure $¿h\rho g$]

$\delta g R¿$

$\delta¿$

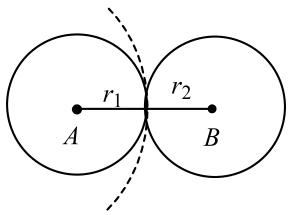
$(\rho+\delta)\sin\theta=(\rho-\delta)\cos\theta$

$\tan\theta=\frac{(\rho-\delta)}{(\rho+\delta)}\Rightarrow\theta=\tan^{-1}\left(\frac{\rho-\delta}{\rho+\delta}\right)$

234 **(c)**

Let radius of curvature of the common internal film surface of the double bubble formed be r'. Then, excess of pressure as

compared to atmosphere inside A is $\frac{4T}{r_1}$ and B is $\frac{4T}{r_2}$



The pressure difference is

$\frac{4T}{r_1}-\frac{4T}{r_2}=\frac{4T}{r'}$

$\Longrightarrow r'=\frac{r_1 r_2}{r_2-r_1}$

$Given, r_1=r_2=r$

$\therefore r'=\frac{r_2}{0}=\infty$

235 **(c)**

$p_1 = p_0 + \rho g h_1$

$p_2 = p_0 + \rho g h_2 = p_0 + 2\rho g h_1$

¿ $2(p_0 + \rho g h_1) - p_0 = 2p_1 - p_0 (p_2 < 2p_1)$

236 **(c)**

Surface energy = surface tension × surface area

$E = S \times 2A$

New surface energy, $E_1 = S \times 2(A/2) = S \times A$

% decrease in surface energy ¿ $\frac{E - E_1}{E} \times 100$

¿ $\frac{2SA - SA}{2SA} \times 100 = 50\%$

237 **(b)**

Mass of the cylinders¿ $AL(\rho_1 + \rho_2)$. As cylinders float with length $L/2$ outside the water, therefore length of cylinder inside the water¿ $3L/2$. When cylinders are floating, then, weight of cylinder ¿ weight of water displaced by cylinder

So $AL(\rho_1 + \rho_2) g = A(3L/2) \times 1 \times g$

Or $\rho_1 + \rho_2 = 3/2$

As $\rho_1 < \rho_2$, so $\rho_1 < 3/4$

238 **(c)**

$Surface\ energy = surface\ tension \times surface\ area$

$E = T \times 2A$

New surface energy,

$E_1 = T \times 2\left(\frac{A}{2}\right) = T \times A$

$\%\ decrease \in surface\ energy = \frac{E - E_1}{E} \times 100$

¿ $\frac{2TA - TA}{2TA} \times 100 = 50\%$

239 **(b)**

$V = a_1 a_2 \sqrt{\frac{2(p_1 - p_2)}{\rho(a_1^2 - a_2^2)}}$

¿ $\pi r_1^2 \times \pi r_2^2 \sqrt{\frac{2(p_1 - p_2)}{\rho[(\pi r_1^2)^2 - (\pi r_2^2)^2]}}$

¿ $\pi r_1^2 r_2^2 \sqrt{\frac{2(p_1 - p_2)}{\rho(r_1^4 - r_2^4)}}$

¿ $\frac{22}{7} \times (0.1)^2 \times (0.04)^2 \sqrt{\frac{2 \times 10}{(1.25 \times 10^3)[(0.1)^4 - (0.04)^4]}}$

¿ $6.4 \times 10^{-4} m^3 s^{-1}$

240 **(b)**

When life is accelerated downwards, the observed weight of body in a lift decreases. Hence, to counter balance the upward pull due to surface tension on the liquid meniscus, the height through which the liquid rises must increase

241 **(a)**

Liquid flows, from high pressure to low pressure. Hence, pressure of liquid in bigger diameter portion of tube is greater than in small diameter portion of tube

242 **(d)**

Given $A = 0.5 \times 10^6 mm^2; V = 200 \times 10^3 mm^3$

$\frac{dV}{dt} = \frac{d(Al)}{dt} = A\frac{dl}{dt} = Av$

$v = \frac{1}{A}\left(\frac{dV}{dt}\right) = \frac{1}{0.5 \times 10^6}(200 \times 10^3) \Rightarrow v = 0.4\, mm s^{-}$

243 **(d)**

Let depth of lake is x cm.

$\therefore p_1 V_1 = p_2 V_2$

$(pdg + xdg)\left(\frac{4}{3}\pi r^3\right) = pdg$ ¿

$(p + x) r^3 = p(8r^3)$

$x = 8p - p$

$x = 7p$

244 **(d)**

Velocity of efflux $v = \sqrt{2gh}$

But $h\rho g = p$

$\therefore hg = \frac{p}{\rho}$

$\therefore v = \sqrt{\frac{2p}{\rho}}$

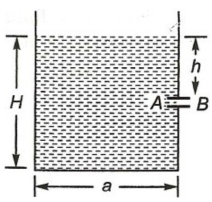
¿ $\sqrt{\frac{2 \times 6.4 \times 10^5}{800}} ms^{-1}$

¿ $40\, ms^{-1}$

245 **(d)**

Bernoulli's theorem is a form of conversion of energy, hence we have

$H_0 + h\rho g = H_0 + \frac{1}{2}\rho v^2$



When vessel is accelerated down with an acceleration g (free fall), then pseudo acceleration g will act vertically upwards and effective value of g is zero. Hence, water will not flow.

246 **(c)**

Work done = Change in surface energy

$w = 2T \times 4\pi\left(R_2^2 - R_1^2\right)$

¿ $2 \times 0.03 \times 4\pi\left[(5)^2 - (3)^2\right] \times 10^{-4}$

¿ $0.4\pi\, mJ$

247 **(b)**

Work done against air friction is the average gain in KE before attaining the terminal velocity

$W_1 = \dfrac{0 + \frac{1}{2} m v_{ter}^2}{2} = \dfrac{1}{4} m v_{ter}^2$

Work done against air friction after attaining terminal velocity, velocity is

$W_2 = \dfrac{1}{2} m v_{max}^2$

$\therefore W_2 > W_1$

248 **(d)**

$V = \dfrac{\pi p r^4}{8\eta l} \therefore V \propto P r^4$ ¿ and l are connected]

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

249 **(c)**

Let A be the area of cross-section of the cylindrical vessel and x cm be the height of mercury in vessel.

The height of water in the vessel ¿ $(29.2 \times x)$ cm

As per question

$Ax \times 13.6 = (29.2 - x) \times 1$ or $x = 2\, cm$

$\therefore$ Height of water column

¿ $(29.2 - 2) = 27.2\, cm$

$\therefore$ Pressure of the liquids at the bottom

¿ 27.2 cm of water column +2 cm of Hg column

¿ $\dfrac{27.2}{13.6}$ of Hg column +2 cm of Hg column

¿ 4 cm of Hg column

250 **(d)**

Pressure at depth $h = p_a + \rho g h$

where p_a is atmospheric pressure

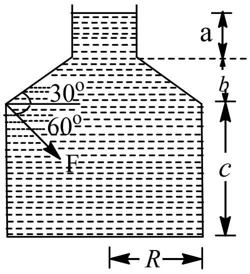
¿ $1.01 \times 10^5\, Nm^2$

$\therefore \quad p_{total} = 1.01 \times 10^5 + 10^3 \times 10 \times 20$

¿ $3.01 \times 10^5\, Pa = 3\, atm$

251 **(c)**

When jar is placed in vacuum, the liquid level rises up to the top of jar. The force exerted by liquid on the base of jar = force due to vertical column of liquid of height $(a+b+c)$+ vertical downward



Component of thrust F acting on the portion BC of jar

¿ $(a+b+c)\rho g \times \pi R^2 + F \sin 60°$

¿ greater than $(a+b+c)\rho g \times \pi R^2$

252 **(a)**

From Bernoulli's equation, the sum of all forms of energy in a fluid flowing along an enclosed path (a streamline) is the same at any two points in the path. Therefore,

$$p+\frac{1}{2}\rho v_1^2 = p' + \frac{1}{2}\rho v_2^2$$

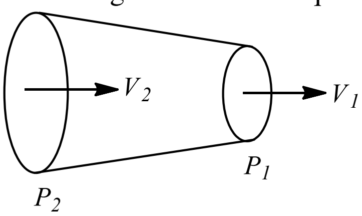
$$Given, v_2 = 2v, v_1 = v$$

$$\therefore p + \frac{1}{2}\rho v^2 = p' + \frac{1}{2}\rho ¿$$

$$\Longrightarrow p' = p - \frac{3}{2}\rho v^2$$

253 **(c)**

According to Bernoulli's equation for horizontal pipe,



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

$$\Longrightarrow p_1 + \frac{1}{2}\rho(v_1^2 - v_2^2) = p_2$$

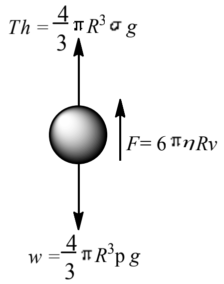
$$\Longrightarrow p_2 = 50 \times 10^3 + \frac{1}{2} \times 10^3 \times (1^2 - 2^2)$$

$$\Longrightarrow p_2 = 50 \times 10^3 - 1.5 \times 10^3$$

¿ $48.5\,kPa$

254 **(c)**

If a sphere of mass M and radius R is dropped in a liquid, its weight $Mg\left(¿\frac{4}{3}\pi R^3 \rho g\right)$ acts vertically downwards. While upthrust $\frac{4}{3}\pi R^3 \sigma g$ and viscous force $6\pi\eta R v$ acts vertically upwards. Initially the body will be accelerated down. At a certain instant when viscous force F will balance the net downward force, acceleration will become zero and the body will fall with constant velocity.



$$\therefore 6\pi\eta R v_T = \frac{4}{3}\pi R^3 (\rho - \sigma) g$$

$$ie, v_r = \frac{2}{9} R^2 \left(\frac{\rho - \sigma}{\eta}\right) g$$

¿ $v_T \propto R^2$

255 **(c)**

Force exerted by the liquid on the base of the vessel is $F = mg$

Here, $m_A = m_B = M_C$

$\therefore \; F_A = F_B = F_C$

256 **(a)**

Accordingly

$$\frac{4T}{r_1} = 3 \times \frac{4T}{r_2} \Longrightarrow \frac{r_1}{r_2} = \frac{1}{3}$$

Ratio of surface areas

$$\frac{A_1}{A_2} = \frac{4\pi r_1^2}{4\pi r_2^2} = \frac{1}{9}$$

257 **(b)**

Let specific gravities of concrete and saw dust are ρ_1 and ρ_2 respectively

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

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

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

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

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

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

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

258 **(d)**

Application of Bernoulli's theorem

259 **(c)**

Total weight in right hand $¿ 10+1=11\ kg$

260 **(c)**

Since cross-sectional area is halved, therefore, velocity is doubled.

Now, $p_1 = 2000\ Pa, v_1 = 1\ ms^{-1}$

$p_2 = ?, v_2 = 2\ ms^{-1}$

$$Again\ p_2 + \frac{1}{2} \times 1000 \times 2 \times 2 = 2000 + \frac{1}{2} \times 1000 \times 1 \times$$

$$¿ p_2 = 2000 + 500(1-4) = 500\ Pa$$

262 **(d)**

Terminal velocity, $v_T \propto r^2$

$$¿ \frac{v_{T_1}}{v_{T_2}} = \frac{r_1^2}{r_2^2}$$

$$\therefore \sqrt{\frac{9}{4}} = \frac{r_1}{r_{20}}$$

$$¿ \frac{r_1}{r_2} = \frac{3}{2}$$

$$\therefore v = \frac{4}{3}\pi r^3$$

$$¿ \frac{v_1}{v_2} = \frac{r_1^3}{r_2^3} = \frac{27}{8}$$

263 **(b)**

By Pascal's law

$$\frac{F}{A} = \frac{f}{a}$$

$$¿ f = \frac{Fa}{A} = \frac{100\,g \times (\pi r)^2}{(\pi \times 4r)^2}$$

$$¿ 6.25\,g = 62.5\ N$$

264 **(a)**

$$Velocity\ v = \frac{2}{9}\frac{(\rho-\sigma)r^2 g}{\eta}$$

$$\therefore v \propto (\rho - \sigma)$$

$$\frac{v_1}{v_2} = \frac{(\rho_1 - \sigma)}{(\rho_2 - \sigma)} = 0.1\,m^{-1}$$

265 **(d)**

Let radii of two soap bubble are a and b respectively and radius of single larger bubble is c.

As excess pressure for a soap bubble is $\frac{4T}{r}$ and external pressure p

$$p_i = p + \frac{4T}{r}$$

$$So, p_a = p + \frac{4T}{a}, p_b = p + \frac{4T}{b}$$

$$¿ p_c = p + \frac{4T}{c} \ldots\ldots(i)$$

$$¿ V_a = \frac{4}{3}\pi a^3, V_b = \frac{4}{3}\pi b^3$$

$$¿ V_c = \frac{4}{3}\pi c^3 \ldots\ldots\ldots(ii)$$

Now as mass is conserved.

$$\mu_a + \mu_b = \mu_c$$

$$ie, \frac{p_a V_a}{RT_a} + \frac{p_b V_b}{RT_b} + \frac{p_c V_c}{RT_c} (as\ pV = \mu RT)$$

As temperature is constant,

$$ie, T_a = T_b = T_c$$

$$So, p_a V_a + p_b V_b = p_c V_c$$

Which in the light of Eqs. (i) and (ii) becomes,

$$\left(p + \frac{4T}{a}\right)\left(\frac{4}{3}\pi a^3\right) + \left(p + \frac{4T}{b}\right)\left(\frac{4}{3}\pi b^3\right)$$

$$¿ \left(p + \frac{4T}{c}\right)\left(\frac{4}{3}\pi c^3\right)$$

$$ie, 4T(a^2 + b^2 - c^2) = p(c^3 - a^3 - b^3) \ldots\ldots\ldots(iii)$$

$$Now, V = \frac{4}{3}\pi(a^3 + b^3 - c^3)$$

$$¿ A = 4\pi(a^2 + b^2 - c^2)$$

$$\therefore \frac{TA}{\pi} = \frac{-3}{4\pi} = Vp$$

$$¿ 4\,TA + 3\,pV = 0$$

266 **(d)**

Increase in surface energy = surface tension × increase in surface area

$$¿ S(1000 \times 4\pi r^2 - 4\pi R^2)$$

$$\left(100 \times \frac{4}{3}\pi r^3 = \frac{4}{3}R^3 \vee r = R/10\right)$$

$$¿ S \times 4\pi\left(1000 \times \frac{R^2}{100} - R^2\right) = 36\pi R^2 S$$

267 **(a)**

$$h\rho g=\frac{2S}{r} \text{ or } h=\frac{2S}{r\rho g}$$

¿ $$\frac{2\times 75\times 10^{-3}}{\left(\frac{1}{2}\times 10^{-3}\right)\times 10^{3}\times 10}=0.03\,m=3\,cm$$

268 **(c)**

Surface energy is related to the surface tension by the relation

$U=Td\,A$

$Given, T=5\,N\,m^{-1}$

$dA=2\,A$

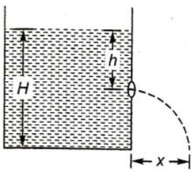
$2\times 0.02=0.04\,m^{2}$

$\therefore U=5\times 0.04$

¿ $0.20\,J=2\times 10^{-1}\,J$

269 **(c)**

Let p be the atmospheric pressure, ρ the density of the liquid and v the velocity of the efflux of the liquid coming out from the orifice.



From Bernoulli's theorem,

$$p+0+\rho g H=p+\frac{1}{2}\rho v^{2}+\rho g(H-h)$$

$$\Longrightarrow \frac{1}{2}\rho v=\rho g h$$

$\Longrightarrow v=$ ¿ $\sqrt{2gh}$

270 **(b)**

Excess the pressure inside the bubble is $p=4T/r$. So, smaller is the radius *r*, the larger is the excess of pressure *p*. It means, the pressure of air is more in bubble *A* than in bubble *B*. So, the air will go from bubble *A* to bubble *B* will grow more until they collapse.

271 **(b)**

If spherical body of radius *a* is dropped in a viscous fluid, it is first accelerated and then its acceleration becomes zero and it attains a constant velocity called terminal velocity.

$$Terminal\ velocity, v=\frac{2}{9}\frac{a^{2}(\rho-\sigma)g}{\eta}$$

where ρ is the density of the body, σ is the density of fluid and η is coefficient of viscosity.

272 **(b)**

Net force = Average pressure × Area – T × 2R

$$\left(P_0+\rho g\frac{h}{2}\right)(2Rh)-T2R$$

$\Rightarrow \vee 2P_0Rh+R\rho g h^{2}-2RT\vee$ ¿

273 **(a)**

Let x be the portion of exposed height of the body of length l, area of cross-section A. As the body is floating, so

$A l \rho g=A(l-x)3\rho g$

or $l=3l-3x$

or $x=2l/3$

or $\frac{x}{l}=\frac{2}{3}$

274 **(d)**

Let V be the volume of wooden ball. The mass of ball is $m=V\rho$

Upward acceleration,

$$a=\frac{upward\ thrust-weight\ of\ ball}{mass\ of\ ball}$$

¿ $$\frac{V\rho_0 g-V\rho g}{V\rho}=\frac{(\rho_0-\rho)g}{\rho}$$

If v is the velocity of ball on reaching the surface after being released at depth h is

$$v=\sqrt{2as}=\left[2\left(\frac{\rho_0-\rho}{\rho}\right)gh\right]^{1/2}$$

If h' is the vertical distance reached by ball above the surface of water, then

$$h'=\frac{v^{2}}{2g}=\frac{2(\rho_0-\rho)}{\rho}gh\times\frac{1}{2g}$$

¿ $$\left(\frac{\rho_0-\rho}{\rho}\right)h=(\rho_0/\rho)$$

275 **(d)**

$$\frac{P_1-P_2}{\rho g}=\frac{v^{2}}{2g}\Rightarrow\frac{4.5\times 10^{5}-4\times 10^{5}}{10^{3}\times g}=\frac{v^{2}}{2g}\therefore v=10\,m$$

276 **(c)**

$$h=\frac{2S\cos\theta}{r\rho g} \text{ or } S=\frac{hr\rho g}{2\cos\theta} \text{ or } S\propto\frac{h\rho}{\cos\theta}$$

$$\frac{S_w}{S_{Hg}}=\frac{h_1}{h_2}\times\frac{\cos\theta_2}{\cos\theta_1}\times\frac{1}{13.6}$$

¿ $$\frac{10}{(-3.42)}\times\frac{\cos 135°}{\cos 0°}=\times\frac{1}{13.6}$$

¿ $$\frac{10}{3.42}\times\frac{0.707}{13.6}=\frac{1}{6.5}$$

277 **(c)**

Volume remains constant after coalescing.
Thus,

$$\frac{4}{3}\pi R^3 = 2\times\frac{4}{3}\pi r^3$$

Where R is radius of bigger drop and r is radius of each smaller drop.

$$\therefore R = 2^{\frac{1}{3}} r$$

Now, surface energy per unit surface area is the surface tension.
So, surface energy, $W = T\Delta A$

$$¿W = 4\pi r^2 T$$

Therefore, surface energy of bigger drop

$$W_1 = 4\pi ¿$$

Surface energy of smaller drop

$$W_2 = 4\pi r^2 T$$

Hence, required ratio

$$\frac{W_1}{W_2} = 2^{2/3} : 1$$

279 **(b)**

Viscosity in gases arises principally from the molecular diffusion that transports momentum between layers off flow. For gases viscosity increases at temperature increases, while in liquids the additional force between molecules become important, hence viscosity tends to fall as temperature increases.

280 **(d)**

$Q = \frac{\pi p r^4}{8\eta l}$ and $Q_1 = \frac{\pi p (r/2)^4}{8\eta(2l)} = \frac{Q}{32}$

281 **(b)**

Excess pressure

$$p = hdg + h' dg$$

$$\Longrightarrow p = dg(h + h')$$

$$Where\, h\, is\, capillary\, rise = \frac{2T}{rdg}$$

$$¿\frac{2\times7\times10^{-2}}{25\times10^{-5}\times10^3\times10} = 0.056\,m$$

$$\therefore p = 10^3\times10[0.056+0.01]$$

$$¿0.066\times10^4$$

$$¿0.0066\times10^5\,Nm^{-2}$$

282 **(b)**

Thrust on lamina = pressure at centroid × Area

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

284 **(a)**

Excess pressure inside a bubble of radius $R = \frac{2S}{R}$

where S is the surface tension of the liquid.

285 **(d)**

$$v \propto r^2$$

$$\frac{v_1}{v_2} = \frac{r_1^2}{r_2^2}$$

$$\frac{10}{v_2} = \frac{r^2}{8^{2/3} r^2} = \frac{1}{4}$$

$$v_2 = 40\,cm/s$$

287 **(b)**

When a number of small droplets coalesce to form a bigger drop surface energy is released because its surface area decreases.

288 **(a)**

Here, the free liquid surface between the plates will be cylindrical which is curved along one axis (parallel to the plates). The radius of curvature of meniscus, $R = r/2$. For cylindrical surface

$$p_0 - p = \frac{S}{R} = \frac{S}{r/2} = \frac{2S}{r}$$

$$\therefore p = p_0 - \frac{2S}{r}$$

290 **(c)**

Water will not leak out from the hole if the weight of water in the water column is supported by the force due to surface tension.
Using the relation,

$$h = \frac{2T}{r\rho g}$$

$$¿\frac{2\times7.5\times10^{-2}}{0.5\times10^{-3}\times10^3\times10}$$

$$¿3\times10^{-2} m = 3\,cm$$

291 **(c)**

According to the Berboulli's theorem the total energy (pressure energy, potential energy and kinetic energy) of an incompressible and non viscous fluid in steady flow through a pipe remains constant throughout the flow.

$$ie, p + \rho g h + \frac{1}{2}\rho v^2 = constant.$$

So, it is clear that Bernouli's theorem is a consequence of the law of conservation of energy.

292 **(b)**

Upthrust = weight of body

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

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

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

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

293 **(d)**

Let R be the radius of the bigger drop, then

$\text{Volume of bigger drop} = 2 \times \text{volume of small drop}$

$\frac{4}{3}\pi R^3 = 2 \times \frac{4}{3}\pi r^3$

$R = 2^{\frac{1}{3}} r$

Surface energy of bigger drop,

$E = 4\pi R^2 T$

¿$4 \times 2^{\frac{2}{3}} \pi r^2 T$

¿$2^2 \pi r^2 T$

294 **(c)**

Since, the bubbles coalesce in vacuum and there is no change in temperature, hence its surface energy does not change. This means that the surface area remains unchanged. Hence,

$4\pi a^2 + 4\pi b^2 = 4\pi R^2$ or $R = \sqrt{a^2 + b^2}$

295 **(b)**

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

296 **(b)**

Let total volume of iceberg ¿V

Volume of visible part of iceberg¿V_1

$\therefore \text{volume of iceberg inside water} = (V - V_1)$

Now, volume of water displaced by iceberg

¿$(V - V_1)$

Let $\quad \text{density of iceberg} = d$

and $\quad \text{density of water} = D$

Then, applying law of floatation, at equilibrium,

weight of iceberg = weight of displaced water

$Vdg = (V - V_1) Dg$

$\Longrightarrow \frac{V - V_1}{V} = \frac{d}{D}$

$\Longrightarrow 1 - \frac{V_1}{V} = 1 - \frac{d}{D}$

$\frac{V_1}{V} = 1 - \frac{d}{D}$

$\therefore$ Percentage fraction of visible iceberg

$\frac{V_1}{V} \times 100\% = \left(1 - \frac{d}{D}\right) \times 100\%$

Here, $\quad d = 917\,kg\,m^{-3}$, $D = 1024\,kg\,m^{-3}$

$\therefore \frac{V_1}{V} \times 100\% = \left(1 - \frac{917}{1024}\right) \times 100\%$

¿$\frac{10700}{1024}\% \approx 10\%$

297 **(c)**

From Bernoulli's theorem,

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

$\Longrightarrow g h = \frac{1}{2} v_1^2\left(\left(\frac{v_2}{v_1}\right)^2 - 1\right)$

$\Longrightarrow g h = \frac{1}{2} v_1^2\left(\left(\frac{A_1}{A_2}\right)^2 - 1\right)$ $\therefore (A$¿¿$1 v_1 = A_2 v_2)$¿

$\Longrightarrow \left(\frac{A_1}{A_2}\right)^2 = 1 + \frac{2hg}{v_1^2}$

$\Longrightarrow \left(\frac{D_1}{D_2}\right)^4 = 1 + \frac{2hg}{v_1^2}$

$\Longrightarrow D_2 = \frac{D_1}{\left(1 + \frac{2gh}{v_1^2}\right)^{1/4}}$

¿$\frac{8 \times 10^{-3}}{\left(1 + \frac{2 \times 10 \times 0.2}{(0.4)^2}\right)^{1/4}} = 3.6 \times 10^3 m$

298 **(c)**

$p = \frac{2S}{r} = \frac{2 \times 70 \times 10^{-3}}{10^{-3}} = 140\,N\,m^{-2}$

299 **(a)**

Volume of log of wood $V = \frac{mass}{density} = \frac{120}{600} = 0.2\,m^3$

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

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

Weight of displaced liquid ¿ $V_{\sigma g}=0.2\times 10^3\times 10\,N$

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

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

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

300 **(b)**

$v\propto \frac{\rho-\rho_0}{\eta}$

$\frac{v_2}{v_1}=\frac{\rho-\rho_{02}}{\rho-\rho_{01}}\times\frac{\eta_1}{\eta_2}$

¿ $\frac{7.8-1.2}{7.8-1}\times\frac{8.5\times 10^{-4}\times 10}{13.2}$

¿ $6.25\times 10^{-4}\,cm/s$

301 **(a)**

Density of the liquid $d=\frac{1-\frac{1}{3}}{1-\frac{3}{4}}=\frac{\frac{2}{3}}{\frac{1}{4}}=\frac{8}{3}$

302 **(c)**

Volume of ice ¿ $\frac{M}{\rho}$, volume of water ¿ $\frac{M}{\sigma}$

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

303 **(c)**

Volume of ice ¿ $\frac{m}{x}$

$\therefore Change \in volume=\frac{m}{y}-\frac{m}{x}$

304 **(a)**

Critical velocity $v=N_R\frac{\eta}{\rho r}$

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

305 **(c)**

$P_1V_1=P_2V_2\Rightarrow (P_0+h\rho g)V=P_0\times 3V$

$\Rightarrow h\rho g=2P_0\Rightarrow h=\frac{2\times 75\times 13.6\times g}{\frac{13.6}{10}\times g}=15\,m$

306 **(a)**

According to principle of continuity,

$Av=constant$

¿ $A_1v_1=A_2v_2$

¿ $\pi r_1^2 v_1=\pi r_2^2 v_2$

$Given, r_1=\frac{4}{2}cm=0.02\,m,$

$r_2=\frac{2}{2}cm=0.01\,m,$

$v_1=3\,ms^{-1}$

$\therefore \pi(0.02)^2\times 3=\pi(0.01)^2 v_2$

¿ $v_2=\left(\frac{0.02}{0.01}\right)^2\times 3=12\,ms^{-1}$

307 **(a)**

If l and r be the length and radius of the tube and p the pressure difference, then from Poiseuille's formula, volume of liquid flowing per second is given by

$Q=\frac{\pi p r^4}{8\eta l}$

$\therefore Fluid\,resistance=\frac{8\eta l}{\pi r^4}$

When capillaries are connected in series then equivalent fluid resistance is

$R_{eq}=R_1+R_2$

¿ $\frac{8\eta l}{\pi p r^4}+\frac{8\eta(2L)}{\pi(2R)^4}=\frac{9}{8}\left(\frac{8\eta l}{\pi p r^4}\right)$

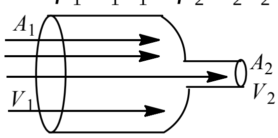
$\therefore Net\,rate\,of\,flow=\frac{p}{R_{eq}}=\frac{p}{\frac{9}{8}\left(\frac{8\eta l}{\pi p r^4}\right)}=\frac{8}{9}$

308 **(c)**

From the equation of continuity, the amount of mass that flows past any cross-section of a pipe has to be the same as the amount of mass that flows past any other cross-section.

$ie, m_1=m_2$

$\Longrightarrow \rho_1 A_1 v_1=\rho_2 A_2 v_2$



$Given\,\rho_1=\rho_2\,A_2=\frac{A_1}{2}$

$\therefore A_1v_1=\frac{A_1}{2}v_2$

$\Longrightarrow v_2=2v_1$

310 **(b)**

Here, $p_1=2\,cm\,of\,Hg$

$¿ 2 \times 13.6 \times 980$

$¿ 2.666 \times 10^4 \, dyne\, cm^{-2}$

$v_1 = 32\, cms^{-1}, v_2 = 65\, cms^{-1}$

For a horizontal pipe, according to Bernoulli's theorem,

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

$$¿ p_2 = p_1 + \frac{1}{2}\rho\left(v_1^2 - v_2^2\right)$$

$$¿ p_2 = 2.666 \times 10^4 + \frac{1}{2} \times ¿$$

$$¿ 2.666 \times 10^4 - 0.16 \times 10^4$$

$$¿ \frac{2.506 \times 10^4}{13.6 \times 980} = 1.88\, cm\, of\, Hg$$

311 **(c)**

Excess of pressure inside a soap bubble

$$p = \frac{4T}{R}$$

$$¿ \frac{p_1}{p_2} = \frac{R_2}{R_1}$$

$Given, p_1 = 3p_2$

$$\therefore \frac{3p_2}{p_2} = \frac{R_2}{R_1}$$

$$¿ \frac{R_1}{R_2} = \frac{1}{3}$$

Therefore, ratio of volume of bubbles

$$\frac{V_1}{V_2} = \frac{\frac{4}{3}\pi R_1^3}{\frac{4}{3}\pi R_2^3}$$

$$¿ \frac{R_1^3}{R_2^3} = \left(\frac{1}{3}\right)^3 = \frac{1}{27}$$

$\therefore V_1 : V_2 = 1 : 27$

313 **(d)**

Terminal velocity, $v = \frac{2r^2(\rho - \rho_0)g}{9\eta}$

Or $\frac{v}{r^2} = \frac{2(\rho-\rho_0)g}{9\eta} = ¿$ constant

314 **(c)**

Velocity head, $h = \frac{1}{2}\frac{v^2}{g}$ or $v = \sqrt{2gh}$

$¿ \sqrt{2 \times 10 \times 0.1} = 1.4\, m\, s^{-1}$

315 **(c)**

Given, velocity of river, $(v) = 2\, ms^{-1}$

Density of water, $\rho = 1.2\, gcc^{-1}$

Mass of each cubic metre,

$$m = \frac{1.2 \times 10^{-3}}{¿¿}$$

$$\therefore kinetic\ energy = \frac{1}{2}mv^2$$

$$¿ \frac{1}{2} \times 1.2 \times 10^3 \times (2)^2$$

$$¿ 2.4 \times 10^3 J = 2.4\, kJ$$

316 **(a)**

When air stream is produced in between two suspended balls, the pressure there becomes less than the pressure on the opposite faces of the balls. Due to which the balls are pushed towards each other

317 **(a)**

Volume of liquid flowing per second through each of the two tubes in series will be the same. So

$$V = \frac{\pi p_1 R^4}{8\eta L} = \frac{\pi p_2 (R/2)^4}{8\eta(L/2)} \text{ or } \frac{p_1}{p_2} = \frac{1}{4}$$

318 **(c)**

Pressure at neck of bottle

$$p_1 = \frac{F_1}{A_1} = \frac{F_1}{\pi r_1^2}$$

Similarly, pressure at bottom of bottle

$$p_2 = \frac{F_2}{A_2} = \frac{F_2}{\pi r_2^2}$$

According to Pascal's law, liquids transmits pressure equal in all directions.

$$\therefore \frac{F_2}{A_2} = \frac{F_2}{\pi r_2^2} \vee F_2 = F_1 \times \left(\frac{r_2}{r_1}\right)^2$$

$$¿ 12 \times \left(\frac{15}{3}\right)^2 = 12 \times 25 = 300\, N$$

319 **(d)**

Upthrust – weight of body = apparent weight

$VDg - Vdg = Vda$

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

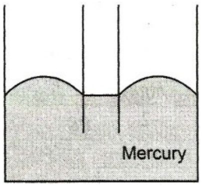
The velocity gained after fall from h height in air, $v = \sqrt{2gh}$

Hence, time to come in rest

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

320 **(d)**

Due to its adhesive nature, mercury depresses below the free surface of the liquid at the point of contact in the container (as shown in figure) when the capillary tube is dipped in it.



321 **(b)**

$v=\frac{2r^2\rho g}{9\eta}r \Rightarrow v\propto r^2\rho$

But mass, $m=\frac{4}{3}\pi r^3\rho$ or $\rho\propto m/r^3$;

Hence, $v\propto r^2(m/r^3)$ or $v\propto m/r$

322 **(a)**

Pressure is independent of area of cross-section

324 **(a)**

If h is the initial height of liquid in drum above the small opening, then velocity of efflux, $v=\sqrt{2gh}$. As the water drains out, h decreases, hence v decreases. This reduces the rate of drainage of water. Due to which, as the drainage continues, a longer time is required to drain out the same volume of water

325 **(b)**

Ice is lighter than water. When ice melts, the volume occupied by water is less than that of ice. Due to which the level of water go down

326 **(a)**

$\frac{Volume\ of\ cube\ submerged}{Total\ volume}=\frac{Density\ of\ cube\ mat}{Density\ of\ water}$

$\Longrightarrow\frac{10-4}{10}=\frac{d}{1}$

$\therefore d=\frac{6}{10}=0.6\,g\,cm^{-3}$

327 **(a)**

Let h be the desired height of liquid in cylinder for which the force on the bottom and sides of the vessel is equal

Force on bottom $¿\rho gh\times\pi R^2$

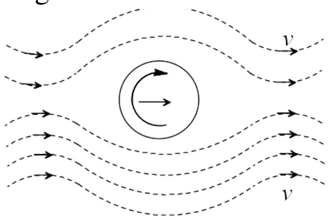
Force on the walls of vessel

$¿\rho g(h/2)\times 2\pi R h$

$¿\rho g\pi h^2 R=\rho g h\pi R h$ or $R=h$

328 **(b)**

The streamlines of air for a ball which is moving and spinning at the same time is as shown in figure below. The ball is moving forward and relative to it the air is moving backwards. Therefore, the velocity of air above the ball relative to it is larger and below it is smaller. The streamlines thus get crowded above and rarified below. This difference in the velocities of air results in the pressure difference between the lower and upper faces and there is a net upward force on the ball. This dynamic lift due to spinning is known as magnus effect



329 **(b)**

Weight the body = Weight of liquids displaced

$V\times d\times g=\frac{V}{2}\times 0.8\times g+\frac{V}{2}\times 13.6\times g$

$d=\frac{0.8}{2}+\frac{13.6}{2}=0.4+6.8$

$¿7.2\,g\,cm^{-3}$

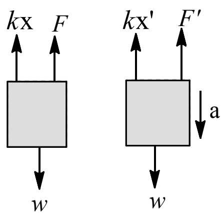
330 **(b)**

There will be no over flowing of liquid in a tube of insufficient height but there will be adjustment of the radius of curvature of meniscus so that $hR=¿$ a finite constant

331 **(c)**

Let k be the spring constant of spring and it gets compressed by length x in equilibrium position. Let m be the mass of the block and F be the upward thrust of water on block. When the block is at rest,

$w=kx+F$ or $w-F=kx$



When the vessel moves downwards with acceleration $a(¿g)$ the effective downward acceleration$¿g-a$.

Now upthrust is reduced say it becomes F''

Where $F' = \frac{F}{g}(g-a)$

In figure, then

$w - kx' - F' = ma$

or $w - kx' - \left(\frac{g-a}{g}\right)F = \frac{wa}{g}$

or $(w-F) - kx' + \frac{a}{g}F = \frac{wa}{g}$

or $kx - kx' + \frac{a}{g}F = \frac{wa}{g}$

or $x' = x + (F-w)\frac{a}{gk}$

hence, the spring length will increase

332 **(b)**

According to equation of continuity,

$av = constant$

$\therefore For\,tube, (8\times10^{-4})\times\left(\frac{0.15}{60}\right) = a_1 v_1$

$For\,holes\,(40\times10^{-8})\times v = a_2 v_2$

$\therefore a_1 v_2 = a_2 v_1$

$\therefore 40\times10^{-8}\times v = \frac{8\times10^{-4}\times0.15}{60}$

$\Longrightarrow v = \frac{8\times10^{-4}\times0.15}{40\times10^{-8}\times60} = 5\,ms^{-1}$

334 **(d)**

The rate of flow of liquid (V) through capillary tube is

$V = \frac{\pi p r^4}{8\eta l} = p\left(\frac{\pi r^4}{8\eta l}\right) = \frac{p}{R} = \frac{pressure\ difference}{resistance}$

Where, $R = \frac{8\eta hl}{\pi r^4}$

When two tubes are in series

Total resistance $R = R_1 + R_2$

Rate of flow of liquid, $V' = \frac{p}{R_1 + R_2}$

¿ $\frac{p}{\frac{8\eta}{\pi}\left[\frac{l_1}{r_1^4} + \frac{l_2}{r_2^4}\right]} = \frac{\pi p}{8\eta}\left[\frac{l_1}{r_1^4} + \frac{l_2}{r_2^4}\right]^{-1}$

335 **(a)**

For air, $\eta \propto \sqrt{T}$

336 **(b)**

$W = 2\times T\times\Delta A$

¿ $2\times72\times(0.6-0.5)\times10 = 144\,erg$

337 **(a)**

The aerofils are so designed that

$P_{upper\,side} < P_{lower\,side}$

So that the aerofils get a lifting force in upward direction. According to Bernoulli's theorem, where the pressure is large, the velocity will be minimum or *vice-versa*

Thus, $V_{upper\,side} > v_{lower\,side}$

338 **(b)**

Difference of pressure between sea level and the top of hill

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

and pressure difference due to h metre of air

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

By equating (i) and (ii) we get

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

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

∴ Height of the hill ¿ $2.5\,km$

339 **(a)**

Given size of the plate ¿ $2\,m\times5\,m$ and

Greatest and least depths of the plate are 6m and 4m

We know that area of the plate $A = 2\times3 = 6\,m^2$

And depth of centre of the plate

x $-¿=\frac{6+4}{2}=5\,m¿$

∴ Total thrust on the plate

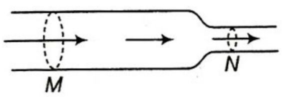
$\rho = \rho_w g \vec{A}_x$

¿ $10^3\times9.8\times6\times5$

¿ 294×10^3 N

340 **(c)**

The velocity of flow will increases if cross-section decreases and $vice-versa$



$ie, A_1 v_1 = A_2 v_2$

¿ $A_v = constant$

Therefore, the rate of liquid flow will be greater at *N* than at *M.*

341 **(b)**

Work done = surface tension × increase in area

¿ $1.9\times10^{-2}\times(4\pi R^2)\times2$

¿ $1.9\times10^{-2}\times4\times\pi(1\times10^{-2})^2\times2$

$¿ 15.2 \times 10^{-6} \pi J$

342 **(c)**

Let $A =¿$ The area of cross section of the hole

$v =¿$ Initial velocity of efflux

$d =¿$ Density of water

Initial volume of water flowing out per second $¿ Av$

Initial mass of water flowing out per second $¿ Avd$

Rate of change of momentum $¿ Ad v^2$

Initial downward force on the flowing out water

$¿ Ad v^2$

So equal amount of reaction acts upwards on the cylinder

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

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

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

343 **(c)**

Specific gravity of alloy $¿ \frac{Density\ of\ alloy}{Density\ of\ water}$

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

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

$\left[As\ specific\ gravity\ of\ substance = \frac{density\ of\ subs}{density\ of\ wa} \right.$

344 **(d)**

Surface tension of water decreases with rise in temperature

345 **(d)**

Streamline flow is more likely for non-viscous and incompressible liquid. So low density and low viscosity is the correct answer.

346 **(b)**

$\frac{\sigma_L}{\sigma_W} = \frac{Upthrust\ on\ body \in liquid}{Upthrust\ on\ body \in water}$

$\frac{1.5}{1} = \frac{x}{(50 - 40) g}$

$\Rightarrow \quad x = 15 g$

$\therefore Upthrust\ on\ body \in liquid = 15 g$

Weight on the body $¿ 50 g$

Hence, body will weight $(50 - 15) = 35 g \in the\ liquid$

347 **(a)**

Here $v_1 = \sqrt{2g(h/2)} = \sqrt{gh}$ ...(i)

Using Bernoulli's theorem, we have

$p_a + \rho g h + 2 \rho g (h/2) = p_a + \frac{1}{2} (2\rho) v_2^2$

Or $v_2 = \sqrt{2gh}$ ...(ii)

$\therefore \frac{v_1}{v_2} = \frac{1}{\sqrt{2}}$

348 **(c)**

Let r be the radius of one droplet .

$Now, \frac{4}{3} \pi R^3 = 10^6 \times \frac{4}{3} \pi r^3$

$r = \frac{R}{100} = \frac{1}{100} cm = 10^{-4} m$

$A_i = 4 \pi R^2$

$A_f = 10^6 \times 4 \pi r^2$

Change in area,

$\Delta A = A_f - A_i = 4\pi \times 99 \times 10^{-4} m^2$

Increase in surface energy

$¿ S \Delta A = 32 \times 10^{-2} \times 4 \pi \times 99 \times 10^{-4} J$

$¿ 3.98 \times 10^{-2} J$

The increase in surface energy is on the expense of internal energy, so energy expended $¿ 3.98 \times 10^{-2} J$

350 **(b)**

Buoyant force = weight of the body in air – weight of the body in liquid

$¿ 4 - 3 = 1 N$

351 **(a)**

The rise or fall of liquid in vertical capillary tubes is called capillary. Water in plant fibres rises due to same phenomenon.

352 **(b)**

Change in surface area

$2 \times 4 \pi [(D/2)^2 - (d/2)^2] = 2 \pi (D^2 - d^2)$

Work done = surface tension $\times$ change in area

$¿ S \times 2 \pi (D^2 - d^2)$

353 **(d)**

Since the tubes A and C are connected to a tube of same area of cross-section, and the liquid flowing there will have same velocity, hence the height of liquid in A and C will be same. Since tube B is connected to a tube of smaller area of cross-section, therefore the liquid is flowing faster in this tube and pressure there is less according to Bernoulli's theorem

354 **(a)**

$Fluid\ resistance\ is\ given\ by\ R=\frac{8\eta L}{\pi r^4}$

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

$R_{eq}=R_1+R_2=\frac{8\eta L}{\pi R^4}+\frac{8\eta \times 2L}{\pi ¿¿}$

Equivalent resistance becomes $\frac{9}{8}$ times so,

$rate\ of\ flow\ will\ be\ \frac{8}{9}X.$

355 **(c)**

$Water\ rise ¿ height\ h=\frac{2T}{\rho g r}$

Potential energy of water column

$U=\frac{mgh}{2}=2\pi T^2/\rho g$

The work performed by force of surface tension is

$W=2\pi r\,T\,h=\frac{4\pi T^2}{\rho g}$

From conversation of energy the heat evolved

$Q=W-U=\frac{2\pi T^2}{\rho g}$

356 **(d)**

Using

Potential energy $¿ mg\,h \Rightarrow 1\times 10^6=m\times 10\times 10$

$m=10^4\,kg/sec$

357 **(a)**

According to Stokes, when a spherical body falls through a viscous fluid, it experiences a viscous force. The magnitude of the viscous force increases with the increases in velocity of the body falling under the action of its weight. As a result, the viscous force soon balance the driving force (weight of the body) and the body starts moving with constant velocity, known as its terminal velocity.

358 **(c)**

Velocity of water 0.15 m below the tap is given by

$v_2^2=v_1^2+2gh$

$=(1.0)^2+2\times 10\times 0.15$

= 1+3=4

$\Rightarrow\ v_2=2\,ms^{-1}$

Now using equation of continuity, we have

$a_1v_1=a_2v_2$

$a_2=¿\frac{a_1v_1}{v_2}=\frac{10^{-4}\times 1}{2}=5\times 10^{-5}m^2 ¿$

359 **(c)**

Pressure at the bottom $\rho=(h_1d_1+h_2d_2)g$

$¿[250\times 1+250\times 0.85]g$

$¿ 250[1.85]g$

$¿ 462.5\,g\,dyne/cm$

361 **(b)**

$\eta=0.07\,kg\,m^{-1}s^{-1}, dv=1ms^{-1},$

$dx=1\,mm=1\times 10^{-3}m, A=0.1\,m^2$

$\therefore F=\eta A\frac{dv}{dx}$

$¿ 0.07\times 0.1\times \frac{1}{1\times 10^{-3}}=7\,N$

362 **(a)**

In air, force of gravity acts on metals. Thus, these have their actual weight. Atomic weight of steel, *ie,* iron is 56 and that of aluminium is 27. Hence, it can be said that in air the weight of aluminium is half the weight of steel.

363 **(b)**

Using Bernoulli's theorem;

$p+\frac{1}{2}\rho v'^2+\rho g h=p+\frac{1}{2}\rho v^2+0$

Where v' is the velocity of the liquid at surface and v is the velocity of efflux. As

$Av'=av$ or $v'=av/A$

$\therefore \frac{1}{2}\rho\left(\frac{av}{A}\right)^2+\rho g h=\frac{1}{2}\rho v^2$

Or $v^2-\frac{a^2v^2}{A^2}=2gh$

Or $v=\sqrt{2gh}/\sqrt{\frac{A^2-a^2}{A^2}}=\sqrt{2gh}\sqrt{\frac{A^2}{A^2-a^2}}$

364 **(a)**

$\eta=\frac{F}{A(dv/dy)}$

$\therefore \eta=\frac{10^{-2}}{(10^3\times 10^{-4})\left(\frac{6\times 10^{-2}}{6\times 10^{-3}}\right)}$

$¿ \frac{10^{-2}\times 6\times 10^{-3}}{10^{-1}\times 6\times 10^{-2}}$

$¿ 10^{-2}\,Nsm^2=0.1\,poise$

365 **(a)**

Velocity of efflux, $v=\sqrt{2gh}$;

Volume of liquid flowing out per sec

$¿ v \times A=\sqrt{2gh}\times A$

$¿\sqrt{2\times 10\times 5}\times\left(10\times 10^{-4}\right)=10^{-2}m^3 s^{-1}$

367 **(a)**

From law of floatation, we know that a body will float in a liquid, when its weight W is equal to the weight w of the liquid displaced by the immersed part of the body will be in equilibrium. A body will be in equilibrium only, if the resultant of all the forces and couples acting on the body is zero. If W and w act along different lines, they will from a couple which will tend to rotate the body. Thus, a floating body can be equilibrium, if no couple acts on it. It will be so, if the line of action of W and w is along the same vertical straight line.

Here, in both the situations, as the mass of floating block remains same, hence according to principle of floatation mass of volume of water displaced also remains same. Hence, water level will remain same in both the cases.

368 **(a)**

Net force on the ball = downward force−upward force

$¿\frac{mg}{2}$

$\frac{3}{4}\pi r^3(\rho-\sigma)g-6\pi\eta rv=\frac{mg}{2}$

$\frac{4}{3}\pi r^3(\rho-\sigma)g-6\pi\eta rv=\frac{1}{2}\left(\frac{4}{3}\pi r^3\rho\right)g$

$r^2(\rho-\sigma)g-\frac{9}{2}\eta v=\frac{1}{2}r^2\rho g$

$\frac{9}{2}\eta v=r^2(\rho-\sigma)g-\frac{1}{2}r^2\rho g$

$¿\frac{1}{2}r^2\rho g-r^2\sigma g$

$\frac{9}{2}\eta v=\frac{1}{2}r^2 g(\rho-2\sigma)$

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

369 **(a)**

If r is the radius of small droplet and R is the radius of big drop, then according to question,

$\frac{4}{3}\pi R^3=10^6\times\frac{4}{3}\pi r^3$ or $r=\frac{R}{100}=0.01R$

$¿ 0.01\times 10^{-2}m=10^{-4}m$

Work done = surface tension × increase in area

$¿ 35\times 10^{-2}\left[10^6\times 4\pi\times\left(10^{-4}\right)^2-4\pi\times\left(10^{-3}\right)^2\right]$

$¿ 4.35\times 10^{-2}$ J

370 **(c)**

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

371 **(b)**

Let $V_0, V_t=¿$ Volume of the metal ball at $0\ °C$ and $t\ °C$ respectively, $\rho_0, p_t=¿$ density of alcohol at $0\ °C$ and $t\ °C$ respecitvely. Then

$W_1=W_0-V_0\rho_0 g$

$W_2=W_t-V_t\rho_t g$

Where $V_t=V_0(1+\gamma_m t)$ and

$$\rho_t=\frac{\rho_0}{(1+\gamma_a t)}g=V_0\rho_0\frac{(1+\gamma_m l)}{(1+\gamma_a l)}$$

As $\gamma_m<\gamma_a$, hence upthrust at $t\ °C$ is less than at $0\ °C$. It means upthrust has been decreased with increase in temperature. Due to which the $W_2>W_1$

372 **(d)**

If V is the volume of the body, its weight$¿V\rho_1 g$. Velocity gained by body when it falls from a height $h_1=\sqrt{2gh_1}$ The weight of liquid displaced by the body as body starts immersing into the liquid $¿V\rho_2 g$. The net retarding force on the body when it starts going in the liquid $F=V(\rho_2-\rho_1)$g

$\therefore$ Retarding, $a=\frac{F}{V\rho_1}=\left[\frac{V(\rho_2-\rho_1)g}{V\rho_1}\right]$

The time of immersion of the body is that time in which the velocity of the body becomes zero. Using the relation $v=u+at$, we have $v=0, u=\sqrt{2gh_1}$,

$$a=\frac{-V(\rho_2-\rho_1)g}{V\rho_1}=-\left(\frac{\rho_2-\rho_1}{\rho_1}\right)g;$$

We have $¿0=\sqrt{2gh_1}-\left(\frac{\rho_2-\rho_1}{\rho_1}\right)gt$

Or $t=\sqrt{\frac{2h_1}{g}}\times\left(\frac{\rho_1}{\rho_2-\rho_1}\right)$

373 **(d)**

$$Specific\ gravity=\frac{weight\ of\ block\in air}{loss\in weight\ of\ block\in liquid}$$

$$¿\frac{60}{60-40}=\frac{60}{20}=3$$

374 **(d)**

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

375 **(c)**

Mass = Volume × Density $\Rightarrow M=\frac{4}{3}\pi r^3\times\rho$

As the density remains constant

$\therefore M \propto r^3$

$\therefore \frac{r_1}{r_2} = \left(\frac{M_1}{M_2}\right)^{1/3} = \left(\frac{M}{8M}\right)^{1/3} = \frac{1}{2} \quad \ldots(i)$

Terminal velocity, $v_T = \frac{2}{9} \frac{r^2(\rho - \sigma)g}{\eta}$

Where, $r =$¿ radius of a spherical body

$\rho =$¿ density of the material of body

$\sigma =$¿ coefficient of viscosity of the medium

As ρ, σ, η remain constant

$\therefore v_T \propto r^2, \therefore \frac{v_{T_1}}{v_{T_2}} = \left(\frac{r_1}{r_2}\right)^2$

$\frac{v}{nv} = \left(\frac{r_1}{r_2}\right)^2$ or $\frac{1}{n} = \left(\frac{1}{2}\right)^2$ [Using (i)]

Or $n = 4$

376 **(c)**

Vertical distance covered by water before striking ground¿$(H-h)$. Time taken is, $t = \sqrt{2(H-h)g}$;

Horizontal velocity of water coming out of hole at $P, u = \sqrt{2gh}$

∴ Horizontal range

¿$ut = \sqrt{2gh} = \sqrt{2(H-g)/g}$

¿$2\sqrt{h(H-h)}$

378 **(a)**

With the increase in temperature, the surface tension of liquid decreases and angle of angle also decreases

379 **(d)**

The upward thrust (*ie* buoyancy force) acts on the body and an equal and opposite force acts on the water so the weight will be the sum of the two

¿$600 + 40 = 640\, g$

380 **(c)**

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

¿$\frac{2}{9} \times \frac{(20 \times 10^{-6})^2 (2000 - 1000) \times 9.8}{1.0 \times 10^{-3}}$

¿$8.7 \times 10^{-4}\, ms^{-1} = 0.87\, mm s^{-1}$

381 **(a)**

Excess pressure is given by $p = \frac{4T}{r}$

$\Longrightarrow r = \frac{4T}{p}$

$\therefore \frac{r_1}{r_2} = \frac{p_2}{p_1} = \frac{1.02}{1.01} = \frac{102}{101}$

$Ratio\ of\ volume's = \frac{\frac{4}{3}\pi r_1^3}{\frac{4}{3}\pi r_2^3} = \frac{(102)^3}{(101)^3} \approx 2$

382 **(c)**

Apparent weight = actual weight − upthrust

$Vd\, g' = Vdg - V\rho g$

$\Longrightarrow g' = \left(\frac{d-\rho}{d}\right) g$

383 **(c)**

Pressure on left end of horizontal tube,

$p_1 = p_0 + h_1 \rho g$

Pressure on right end of horizontal tube,

$p_2 = p_0 + h_2 \rho g$

As $p_1 > p_2$, so acceleration should be towards right hand side. If A is the area of cross-section of the tube in the horizontal portion of U-tube, then

$p_1 A - p_2 A = (l A \rho) a$

Or $(h_1 - h_2)\rho g A = l A \rho a = \frac{g(h_1 - h_2)}{l}$

384 **(b)**

Retarding force acting on a ball falling in to a viscous fluid

$F = 6\pi \eta R v$

$where\ R = radius\ of\ ball,$

$v = velocity\ of\ ball,$

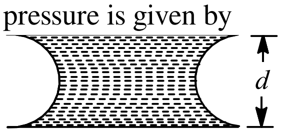
¿$\eta = coefficient\ of\ viscosity$

$\therefore F \propto R \wedge F \propto v$

Or in words, retarding force is directly proportional to both R and v.

387 **(b)**

Let A be the circular area over which the liquid wets the plate and d be the distance between two plates. Mass of liquid drop, $m = Ad\rho$. If S is the force of surface tension of water, then excess of pressure inside the liquid film in excess of atmospheric pressure is given by



$p = \frac{S}{r} = \frac{S}{d/2} = \frac{2S}{d}$

Force of attraction between the plates,

$F=\frac{2S}{d}A\left[\because p=\frac{F}{A}\right]$

Or $F=\frac{2S}{\rho d^2}\times A\rho d=\frac{2Sm}{\rho d^2}$

$¿\frac{2\times 0.07\times(80\times 10^{-6})}{10^3\times(4\times 10^{-8})}=0.28\,N$

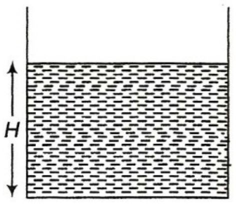
388 **(c)**

Figure shows the flow speed profile for laminar flow of a viscous fluid in a long cylindrical pipe. The speed is greatest along the axis and zero at the pipe walls,

389 **(d)**

Archimedes' upward thrust will be absent for a fluid, if there were no gravity.

390 **(b)**



Apply Bernoullis, theorem

$p_1+0\rho g H=p_{2+¿\frac{1}{2}\rho v^2+\rho g H¿}$

$p_1-p_2=\frac{1}{2}\rho v^2$

$3\times 10^5-1\times 10^5=\frac{1}{2}\rho v^2$

$2\times 10^5=\frac{1}{2}\rho v^2$

$2\times 10^5=\frac{1}{2}\times 10^3\times v^2$

$v^2=400$

$v=\sqrt{400}$

391 **(c)**

When there is equal level of liquid in two arms of U-tube, then height of liquid in each arm of U-tube $¿\frac{h_1+h_2}{2}$. We may consider that a length $h_1-\frac{(h_1+h_2)}{2}=\frac{h_1-h_2}{2}$ of the liquid has been transferred from left arm to right arm of U-tube. The mass of the liquid transferred from left arm to right arm of U-tube$¿\left(\frac{h_1-h_2}{2}\right)A\rho$, where $A=¿$area of cross-section of tube and $\rho=¿$ density of liquid.

The decrease in height of this liquid $¿\left(\frac{n_1-n_2}{2}\right)$

Loss in potential energy of this liquid

$¿\left(\frac{h_1-h_2}{2}\right)^2 A\rho g$

The mass of the entire liquid in U-tube

$¿(h_1+h_2+h)\rho A$

If this liquid moves with velocity v, then its

$KE=\frac{1}{2}(h_1+h_2+h)\rho A v^2$

Using law of conservation of energy, we gave

$\frac{1}{2}(h_1+h_2+h)\rho A v^2=\left(\frac{h_1-h_2}{2}\right)^2 A\rho g$

Or $v=(h_1-h_2)\sqrt{\frac{g}{2(h_1+h_2+h)}}$

392 **(b)**

$Ft=2SA$ or $F=\frac{2SA}{t}=\frac{2SA^2}{At}=\frac{2SA^2}{V}$

$F=\frac{2\times 70\times(40)^2}{0.05}=44.8\times 10^5\,dyne$

$¿44.8\,N\approx 45\,N$

393 **(a)**

Work done = surface tension $\times$ increase in surface area

$¿T(n4\pi r^2-4\pi R^2)$

394 **(b)**

Height, $h\propto 1/R$

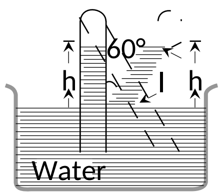
So $h_1/h_2=R_2/R_1=0.4/0.2=2$

396 **(a)**

$\cos 60°=\frac{h}{l}$

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

$\therefore l=152\,cm$



397 **(b)**

Work done = surface tension $\times$ increase in area

$W=¿$ surface tension

$\times[0.10\times 0.006-0.10\times 0.005]\times 2$

¿$7.2 \times 10^{-2} \times 0.10 \times 0.001 \times 2$

¿1.44×10^{-5} J

398 **(c)**

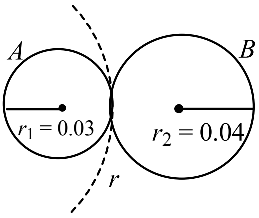
$$P_1 V_1 = P_2 V_2 \Rightarrow (P_0 + h\rho g) \times \frac{4}{3}\pi r^3 = P_0 \times \frac{4}{3}\pi (2r)^3$$

Where, $h=$¿ depth of lake

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

399 **(c)**

Let the radius of curvature of the common internal film surface of the double bubble formed by two bubbles A and B be r.



Excess of pressure as compared to atmosphere inside A is

$$p_1 = \frac{4T}{r_1} = \frac{4T}{0.03}$$

Excess of pressure inside B is

$$p_2 = \frac{4T}{r_2} = \frac{4T}{0.04}$$

In the double bubble the pressure difference between A and B on either side of the common surface is

$$\frac{4T}{0.03} - \frac{4T}{0.04} = \frac{4T}{r}$$

$$\Longrightarrow \frac{1}{0.03} - \frac{1}{0.04} = \frac{1}{r}$$

$$\Longrightarrow r = \frac{0.03 \times 0.04}{0.01} = 0.12\,m$$

400 **(b)**

Terminal velocity

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

$$v \alpha r^2$$

$$\frac{v}{V} = \frac{r^2}{R^2} \Rightarrow V = \frac{vR^2}{r^2}$$

401 **(b)**

$$\Delta p_1 = \frac{4T}{r_1} \wedge \Delta p_2 = \frac{4T}{r_2}$$

$$r_1 < r_2$$

$$\therefore \Delta p_1 > \Delta p_2$$

Air will flow from 1 to 2 and volume of bubble at end-1 will decreases.

402 **(c)**

Rate of flow of water through a capillary tube is

$$V = \frac{\pi R r^4}{8\eta l}$$

As P, η remain the same

$$\therefore \frac{V'}{V} = \frac{(2r)^4}{(r)^4} \times \frac{(l)}{(2l)} = \frac{16}{2} = 8 \Rightarrow V' = 8V$$

403 **(a)**

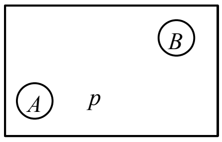
From the principle of continuity,

$Av = constant$

¿ $A_1 v_1 = A_2 v_2$

404 **(b)**

Although not given in the question, but we will have to assume that temperatures of A and B are same.



$$\frac{n_B}{n_A} = \frac{p_B V_B / RT}{p_A V_A / RT} = \frac{p_B V_B}{p_A V_A}$$

$$¿\ \frac{p + 4s/r_A \times 4/3\pi (r_A)^3}{p + 4s/r_B \times 4/3\pi (r_B)^3}$$

$$(s = surface\,tension)$$

$$Substituting\,the\,values, we\,get\ \frac{n_B}{n_A} = 6$$

405 **(b)**

Weight of body

¿ weight of water displaced

= weight of oil displaced

$$\Rightarrow \frac{2}{3}V\rho_w g = \frac{1}{2}V\rho_0 g$$

$$\Rightarrow \rho_0 = \frac{4}{3}\rho_w$$

$\therefore$ Specific gravity of oil ¿ $\frac{\rho_0}{\rho_w} = \frac{4}{3}$

406 **(a)**

Given, $6g = \frac{V}{3} \times 10^3 \times g$ …(i)

And $(6+m)g = V \times 10^3 \times g$ …(ii)

Dividing Eq.(ii) by Eq. (ii) by Eq. (i), we get

$\frac{6+m}{6}=3$

Or $m=18-6=12$ kg

407 **(b)**

Here, diameter $D=1.25\,cm=1.25\times10^{-2}\,m$

Density of water $\rho=10^{3}\,kg\,m^{-3}$

Coefficient of viscosity $\eta=10^{-3}$ Pas

Rate of flow of water $Q=5\times10^{-5}\,m^{3}\,s^{-1}$

Reynold's number $N_R=\frac{v\rho D}{\eta}$ …(i)

Where v is the speed of flow

Rate of flow of water $Q=¿$ Area of cross section × speed of flow

$Q=\frac{\pi D^2}{4}\times v\Rightarrow v=\frac{4Q}{\pi D^2}$

Substituting the value of v in eqn. (i), we get

$N_R=\frac{4Q\rho D}{\pi D^2\eta}=\frac{4Q\rho}{\pi D\eta}$

Substituting the values, we get

$N_R=\frac{4\times5\times10^{-5}\times10^{3}}{\left(\frac{22}{7}\right)\times1.25\times10^{-2}\times10^{-3}}\approx5100$

For $N_R>3000$, the flow is turbulent

Hence, the flow of water is turbulent with Reynold's number 5100

408 **(d)**

Excess pressure inside a liquid drop

$\Delta p=\frac{2T}{R}$

Where T is surface tension and R is radius of liquid drop.

$\therefore \frac{\Delta p_1}{\Delta p_2}=\frac{R_2}{R_1}=\frac{0.75}{0.50}$

$\Longrightarrow \frac{\Delta p_1}{\Delta p_2}=\frac{3}{2}$

409 **(b)**

In figure total force on the ring due to surface tension of soap film $¿(2\pi b)\times2S\sin\theta$

Mass of air entering per second the bubble

$¿$ volume × density $¿(Av)\rho=\pi b^2\times v\rho$

Momentum of air energy per sec

$¿\pi b^2 v\rho\times v=\pi^2 b^2 v^2\rho$

The soap bubble will separate from the ring, when force of surface tension of ring is equal to the force

Or $2\pi b\times2S\times\frac{b}{R}=\pi b^2v^2\rho$ or $R=\frac{4S}{\rho v^2}$

410 **(d)**

Rate of flow under a constant pressure head,

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

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

412 **(c)**

$Av=2Av'$ or $v'=v/2$

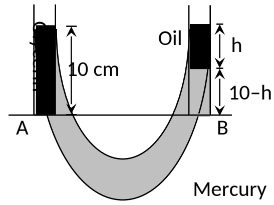
For a horizontal pipe, according to Bernoull's theorem

$p+\frac{1}{2}\rho v^2=P'+\frac{1}{2}\rho\left(\frac{v}{2}\right)^2$

Or $p'=p+\frac{1}{2}\rho v^2\left(1-\frac{1}{4}\right)$

$¿\,p+\frac{3}{8}\rho v^2$

413 **(d)**



At the condition of equilibrium

Pressure at point $A=¿$ Pressure at point B

$P_A=P_B\Rightarrow10\times1.3\times g=h\times0.8\times g+(10-h)\times13.$

By solving we get $h=9.6\,cm$

414 **(b)**

$P+200\times10^{-3}\times1000\times10=P_0$ …(i)

$P_0(500-H)=P.(300\,mm)$

$\Rightarrow P=\frac{P_0(500-H)mm}{300\,mm}$ …(ii)

From (i) and (ii)

$\frac{P_0(500-H)}{300}+2000=P_0\Rightarrow\frac{10^5(500-H)}{300}+2000=$

$\Rightarrow5\times10^7-H\times10^5+6\times10^5=300\times10^5$

$\Rightarrow H=206\,mm$, fall in height $¿\,6\,mm$

415 **(c)**

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