FLUIDS

Atmospheric Pressure

1. Find the exerted by a liquid q, on the dam of width b. as shown in the figure. Atmospheric pressure is p_0.

2. The vessel shown in the figure has two section of area of cross – section A_1 an A_2. A liquid of density p fills both the section upto a height h in each. Consider atmospheric pressure P_o also. Find

(A) The pressure at the base of vessel
(B) The force exerted by the liquid on the base of the vessel.
(C) The downward force by the walls of the vessel at the level B.

3. A vessel with a hole in its bottom is fastened on a cart. The mass of the vessel and the cart is M and the area of the vessel base is A. What force F should the cart be pulled with so that maximum amount of wart remain in the vessel? The dimensions of the vessel are shown in the figure. Assume there is no friction between cart and ground and vessel is fixed with cart.(p is density of water)

PASCAL'S LOW

Exercise – I

Water is poured to same level in each of the vessels shown in the figure, all having the same base area. In which vessel is the force experienced by the base maximum?

4. A vertical u – tube of uniform cross – section contains mercury in both arms. A glycerine (relative density = 1.3) column oflength 10 cm is introduced into one of the arms.Oil of density 800 kg m^{-3} is poured into the other am until the upper surface of the oil and glycerine are at the same horizontal level. Find the length of the oil column. Density of mercury is 13.6×10 kgm^{-3}.

5. For the arrangement shown in thee figure, what I the density of oil?

BAROMETER

Exercise – II

A barometer kept in an elevator accelerating upward read reads 76 cm of mercury column. Is the pressure inside the elevator greater than or less than 76 cm of Hg column.

Archimedes Principle

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

7. A cubical block of wood of edge 3 cm floats kin water. The lower surface of the cube just touché the free end of a vertical spring fixed at the bottom of the pot. Find the maximum weight that can be put on the bock without wetting it. Density of wood = 800 kg/m^{-3} and spring constant of the spring = 50 N/m. Take g = 10 m/s^2. Neglect the volume of the spring.

8. A level controller in shown in the figure. It consists of a thin circular plug of diameter 10 cm and a cylindrical float of diameter 20 cm tied together with a light rigid rod of length 10cm. The plug fits in snugly in a drain hole at the bottom of the tank. As water fills up and the level reaches the height h, the plug opens. Find h. Determine the level of water in the tank when the plug close again. The floats has a mass of 3 kg and the plug may be assumed to be massless.

FLOATATION

9. A cube of wood supporting 200 gm mass just floats in water. When the mass is removed, the cube rises by 2 cm. What is the size of the cube?

10. The 'tip of the iceberg' in popular speech has some to mean a small fraction of something that is mostly hidden. For real icebergs, what is this fraction?

(p_{ice} = 917 kg/m^3, $p_{sea\ water}$ = 1024 kg/m^3)

11. A cubical block of iron of edge 5 cm is floating on mercury in a vessel.

(A) What is the height of the bock above mercury level?

(B) Water is poured into the vessel so that it just covers the iron block. What is the height of the water column?

[Relative density of Hg = 13.6 and that of Iron = 7.2]

12. A piece of copper having an internal cavity weighs 264 gm in air and 221 gm in water. Find the volume of the cavity. [density of copper is 8.8 gm/cc.]

13. A piece of brass (alloy of copper and zinc) weighs 12.9 gm in air. When completely immersed in water, it weighs11.3 gm. What is the mass of copper contained in the alloy?

[Specific gravity of copper and zinc are 8.9 and 7.1, respectively.]

EQUATION OF CONTINUITY

14. Figure shown a liquid being pushed out of a syringe by pressing the piston. The area of cross – section of the piston I 1.0 cm^2 and the of the needle is 10 mm^2. If the piton is pushed at a speed of 1 cm/sec, what is the speed of the outgoing liquid?

VELOCITY OF EFFLUX

Exercise – III

15. The figure shown how the stream of water emerging from a faucet necks down as it falls. The area change from $A_o$to A through a fall of h. at what rate dose the water flow from the tap?

16. Water enters a house through a pipe with inlet diameter of 2.0 cm at an absolute pressure of 4.0 $\times 10^5$ Pa (about 4 atm). A 1.0 cm diameter pipe leads to the second floor bathroom 5.0 m above. When flow speed at the inlet pipe is 1.5 m/s , find the flow speed, pressure and volume flow rate in the bathroom.

17. Water coming out of jet having across sectional area a with a speed v strikes a stationary plate and stops after striking. Find the force exerted by the water jet on the plate.

SURFACE TENSION

Exercise – IV

How do detergents clean dirty clothes?

18. A rectangular plate of dimensions 6 cm × 4 cm and thickness 22 mm is paced with its largest face flat on the surface of water. Find the downward force of the plate due to surface tension. Surface tension of water is 7.0×10^{-2} N/m.

SURFACE ENERGY

Exercise – V

Several small drops of a liquid are added together to make a big droop. How is the temperature of the drops affected?

19. What is the surface energy of a soap bubble of radius r ?

20. A meniscus drop of radius 1 cm is sprayed into 10^6 droplets of equal size. Calculate the energy expended if surface tension of mercury is 435×10^{-3} N/m.

EXCESS PRESSURE

Exercise - VI

21. There is an air bubble of radius 1.0 mm in a liquid of surface tenion0.075 N/m an density 10^3 kg/m^3. The bubble is at a depth of 10.0 cm below the free surface. By what amount I the pressure inside the bubble greater than the atmospheric pressure.

22. What is the excess pressure inside a bubble of soap solution of radius 5.00 mm, given that the surface tension of soap solution at the temperature (20^{o}C I 2.50×19^{-2} N/m^{-1}? If an air bubble of the same dimensions were formed at a depth of 40.0 cm inside a container containing soap solution (of density 1.20), what would be the pressure inside the bubble? (1 atm is 1.01×10^5 Pa)

RISE OF LIQUID IN A TUBE OF INSUFFICIENT LENGTH

23. Water rises to height H in a capillary of radius r an angle of contact is zero as shown in the figure. The density and surface tension of water is $\rho$and T respectively. Acceleration due to gravity is g and atmospheric pressure is P_0. Now, identical capillaries as of (i) are bent indifferent forms as shown in the figure (ii) and (iii).

ENERGY REQUIREDTO RAISE A LIQUID IN A CAPILLARY TUBE:

Exercise – VII

Compare the pressure at the point P in the three tubes shown in the figure.

24. Mercury has an angle of contact equal to 140^o with soda lime glass. A narrow tube of radius 1.00 mm made of this glass is dipped in a trough containing mercury. By what amount doe the mercury dip down in the tube relative to the mercury surface outside? Surface tension of mercury at the temperature of the experiment is 0.465 Nm^{-1}. Density of mercury = 13.6×10^3 kgm^{-3}.

VISCOSITY

25. A metal plate 0.04 m^2 in area is lying on a liquid layer of thickness 10^{-3} m and co- efficient of viscosity 140 poise. Calculate the horizontal force needed to move the plate with a speed of 0.040 m/s.

Exercise VIII
A man waking in a rainstorm can withstand the falling rain drops even though the raindrops fall through a large height. How?

26. An air bubble of radius 1 mm is allowed to rise though along cylindrical column of a viscous liquid of radius 5 cm and travels at a steady rate of 2.1cm/sec. If the density of the liquid is 1.47 gm/cc. Find its coefficient of viscosity. Assume g = 980 cm/ec^2 and neglect the density of air.

PROBLEM

1.A barrier AB of length 12m is hinged at A. At the lower end, a horizontal spring keep the barrier closed. The height of the water is 6m and the width of the barrier is 5m. Water level is 4m below the hinge A. If minimum elongation of spring to keep the barrier closed is 1m, find the spring constant.
[Neglect atmospheric pressure.]

2.A vertical U – tube with two limbs 0.75 m apart is filled with water and rotated about a vertical axis 0.5 m from the left limb, as shown in the figure. Determine the difference in elevation of the water level in the two limbs when the speed of rotation is 60 rpm.

3. A body of density p is released gently on the surface of a layer of liquid of depth 'd' and density σ(p>σ). Show it will reach the bottom of the liquid after a time $\frac{2dp}{g(p - \sigma)}$

(Neglect drag force applied by the liquid on the body).

4. A bent tube is lowered into a water stream as shown in the figure. The velocity of the stream relative to the tube is equal to v = .5 m/s. the closed upper end of the tube located at the height
h_0 = 12 cm has a small orifice. To what height h will the water jet spurt?

5.A cylindrical tank 1m in radius rest on a platform 5m high . Initially the tank is filled with water upto a height of 5m. A plug whose area I 10^{-4} $m^{22}$is removed from an orifice on theside of the tank at the bottom. Calculate
a) initialspeed with which the water flows from the orifice.
b) initial speed with which the water trike the ground and
c) time taken to empty the tank to half its original value.
d) Does the time to empty the tank upon the height of stand?

6. A shown in the figure , a rectangular wire frame ABCD in which side BC is movableissuspended vertically. A mass M is suspended through a string attached to BC. If the shaded portion contains a liquid film and BC is in equilibrium, then find the surface tension of the liquid if BC = ℓ.

7. What is the excess pressure inside a bubble of soap solution having radius 5.00 mm? Given that the surface tension of soap solution at the temperature (20^0C) is $2.50\times10^{-}$ N/m. If an air bubble of the same dimension were formed at a depth of 4.0 cm inside a container containing soap solution
(relative density 1.20), what would be the pressure inside the bubble ? (1atm = 1.01×10^5 Pa)

8. Two long capillary tubs of diameters 5.0 mm and 4.0 mm are held vertically inside water one by on. How much high the water will rise in each tube?
9. Water rises in a capillary tub to a height 2.0 cm. In another capillary whose radius is one - third of it, upto what height will the water rise? Also, if the first capillary is inclined at an angle of 60^0 with the vertical, then what will b the length of water column within the tube?
10.Four drops of equal radii a falling though air with a steady velocity of 5 cm/s. If the four drops coalesced, then find the terminal velocity of the large drop?

OBJECTIVE

1. A cubical water tank is completely filled with water of mass m = 1000 kg. The force exerted by the water on the side wall of the tank is

a) 1.06×10^5 N b) 1.62×10^5 N c) 0.049×10^5 N d) None of these

2.A massless sealed tank of inner volume V and containing a liquid of density p is moving on a frictionless horizontal surface under the action of a constant force F as shown in the figure. The difference in pressure between the points A and B is

a) hpg b) ℓ F/V c) hpg - $\ell\,(F/V)$ d) $(\ell\ F/V)$ + pgh

3. A uniform rod of density p is paced in a wide tank containing a liquid of density p^0 (>p). The depth of liquid in the tank is half the length of the rod.The rod is in equilibrium with the lower end resting on the bottom of the tank. In thisposition, the rod makes an angle 'θ' with the horizontal such that

a) sin θ = 1/2 $\sqrt{p0/p}$

b) sin θ = $p_0/2p$

c) sin θ = $\sqrt{p/p0}$

d) sin θ = p_0/p

4.A piston of a syringe pushes a liquid with a speed of 1 cm/sec. The radii of the syringe tube and the needle are =1cm an r= 0.5mm, respectively. The velocity of the liquid coming out of the needle is

a) 20 cm/sec b) 400 cm/sec c) 10 cm/sec d) none of these

5. In the figure shown, a liquid is flowing through a tube at the rate of 0.1 m^3/sec. The tube is branched into two semicircular tubes of cross sectional areas A/3 and 2A/3. The velocity of liquid at Q is (The cross – section of the main tube (A) = 10^{-2} m^2 and v_P = 0 m/sec.)

a) 5 m/s b) 30 m/s c) 35 m/s d) none of these

6.A small hole is made at a height of h' = $(1/\sqrt{2})$ m from the bottom of a cylindrical water tank and at a depth of h = $\sqrt{2}$ m from the upper level of water in the tank. The distance where the water emerging from the hole strikes the ground is

a) $2\sqrt{2}$ m b) 1m c) 2m d) none of these

7.In a large cylindrical water tank, there are two small holes Q and P on the wall at a depth of h_1 from upper level of water and at a height of h_2 from the power end of the tank, respectively, as shown in the figure. Water streams coming out from both the holes strike the ground at the same point. The ratio of h_1 and h_2 is

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

8.A cylindrical vessel is filled with water upto height h. The water flows out in time t sec. If the water in now filed upto height ηh, wate flow out in time

a) ηt sec   b) η^2 t sec   c) $\sqrt{\eta}$ t sec   d) t/ η sec

9.Two soap bubbles of radii 1×10^{-3} m and 2×10^{-3}coalesce. If the surface tension of liquid is 7×10^{-2} N/m, then the radius of curvature of the common surface will be

a) 4m   b) 4×10^{-3} m   c) 2×10^{-3} m   d) 6×10^{-3} m

10.The surface tension of water is 'T'. A water drop of radius 'R' is spilt into 'n' smaller drops, each of radius 'r' . The work done in this process will be

a) $\frac{4}{3}\pi R^3\left(\frac{1}{r}-\frac{1}{R}\right)T$ b) $8\pi R^3\left(\frac{1}{r}-\frac{1}{R}\right)T$

c) $4\pi R^3\left(\frac{1}{r}-\frac{1}{R}\right)T$ d) $\frac{3}{4}\pi R^3\left(\frac{1}{r}-\frac{1}{R}\right)T$

ASSIGNMENTS

SECTION – I

PART – A(Level – I)

1.A barrel contains a 0.120 m lay of oil floating on water that is 0.50m e. The density of the oil is 600 kg/m^3. (a) What is the gauge pressure at the oil – water interface? (b) What is the gauge pressure at the bottom of the barrel?

2.When the system shown in the adjoining figure is in equilibrium and the areas of coss section of the small an big pistons are 'a' an '10a', then what is the value of m/M?

3.The height of mercury column in a simple barometer is h. As the tube is inclined with the vertical at an angle α, find the length ℓ of the mercury column along the length of the tube.

4.One kilogram of cotton and 1kg of iron are weighed in vacuum. Then, which one of them will weigh more?

5.What will be the fraction of volume of a floating object of volume V_0 and density d_0 above the surface of a liquid of density d?

6.A small spherical ball of density p is gently released in a liquid of density σ(p>σ). Find the initial acceleration of the ball.

7.Water flows steadily through a horizontal tube of variable cross section. If the pressure is 'P' at a point where the velocity of flow is 'v' , what is the pressure at another point where the velocity of flow is 2v (p being the density of water)?

8.Find the amount of energy needed in breaking a drop of liquid of surface tension T and radius R into n drop of radius r each.

9.How is the rise of liquid affected if top of the capillary is closed?

10.A boat of area 10 m^2 floating on the surface of a river is mid to move horizontally with a speed of 2m/ by applying a tangential force. If the river is 1m deep and the water in contact with the bed is stationary, find the tangential force needed to keep the boat moving with same velocity. Assume velocity gradient along the depth of the river is constant and viscosity of water is 0.01 poise.

LEVEL – II

1.A cubical wooden block of specific gravity s_2 as shown in the figure. The atmospheric pressure is P_0. Determine

(i) The force exerted on the face AD, and

(ii) The force exerted on the face BC.

(Density of water is p_w)

2.A concrete sphere of radius 'R' has a cavity of radius 'r' which is packed with sawdust. The relative densities of concrete and sawdust are 2.4 and 0.3, respectively. For this sphere to float with its entire volume submerged under water, what should be the ratio of mass of concrete to mass of sawdust?

3. (A) A how metal sphere of mass m has an instantaneous upward acceleratio9n 'a' when released from rest the volume of the cavity in the sphere.

(B) A wooden cube of side 10 cm and specific gravity 0.8 floats in water with its upper surface horizontal. What depth of the cube remains immersed? What mass of aluminimum of specific gravity 2.7 must be attached to

(I) The upper surface,

(II) The lower surface so that the cube will be just immersed?

4. A solid sphere of mass m = kg and specific gravity s = 0.5 is held stationary relative to a tank filled with water as shown in the figure. The tank is accelerating vertically upward with acceleration α = 2 ms^{-2}.

(A) Calculate the tension in the thread connecting the sphere and the bottom of the tank.

(B) If the thread snaps, calculate the acceleration of the sphere with respect to the tank.

(Density of water is $\rho = 1000$ kg/m^3 and g = 10 m/s^2)

5. A uniform rod AB, 4 m long and weighing 12 kg, is supported at end A, with a 6 kg lead weight at B. The rod floats as shown in the figure with on – half of its length submerged in water. The buoyant force on the lead mass is negliglible as it is negliglible volume. Find the tension in the cord ad total volume of the rod.

6. A tank of cross – sectional area A_1 discharges water through an orifice of area A_2 at the bottom of the tank at a steady rate. If the density of the water is α, find the mass flow rate of water from the tank. Now, if a pipe of area A_2 and length H/2 is attached to the orifice, what I the increase in the flow rate? Find the pressure at point C for the two cases. (Atmospheric pressure = P_0, assuming point C is just outside the tank whose cross – sectional area is A_{1-})

7. Air is streaming past a horizontal airplane wing such that its speed is 120 m/s over the upper surface and 90 m/s at the lower surface. If the density of air is 1.3 kg/m^3 and the wing is 10 m long, and has an average width of 2 metre, then what is the pressure difference on the two sides of the wing?

8. Water flows out of a big tank along a horizontal tube AB of length ℓ and radius r and bent at right angle at the other end as shown in the figure. The rate of flow is Q m^3/s. Calculate the moment of the force exerted by the water on the tube about the end A.

9. (A) Find the work done in increasing the radius of a soap bubble from initial radius r_1 to final radius r_2. [Given T = surface tension of soap solution.]

(B) Two soap bubbles of the same radius r coalesce isothermally to from a bigger bubble of radius R. If the atmospheric pressure is P_0 find the surface tension of the soap solution.

10. A small how vessel which has a small hole in it is immersed in water to a depth of 40 cm before water enters into the vessel. Calculate the radius of the hole.

[Surface tension of water = 70×10^{-3}, density of water = 10^3 kg/m^3]

11. If n identical water droplets falling under gravity with terminal velocity v coalesce to from a singedro which has the terminal velocity 4v, find the number n.

PART – B
OBJECTIVE
(MUTI HOICE SINGLE CORRECT)

1. The pressure of the gas in a cylindrical chamber is p_0. The vertical force exerted by the gas on its hemispherical end is

(A) $P_0 r^2$ (B) $4P_0\pi r^2$ (C) $2P_0\pi r^2$ (D) $P_0\pi r^2$

2. A vessel contains liquid of mass M as shown in the figure. The force N exerted by the bottom of container on the liquid is (Neglect atmospheric pressure)

(A) N = Mg (B) N < Mg (C) N > Mg (D) N = 0

3. A thin rectangular plate of area A is immersed in water vertically. The length of the vertical side immersed in water is h. The thrust on one side of the plate due to water (density of water = ρ) is

(A) $Ah\rho g$ (B) $1/2Ah\rho g$ (C) $\frac{A^2\rho g}{2h}$ (D) $\frac{A^2\rho g}{h}$

4. A right circular cone of base radius R and height H is hanging horizontal via a string liquid of density ρ. Tip of the cone is at a distance h below the free surface of liquid. The force due to liquid on the surface of cone is

(A) $\frac{\pi R^2\rho gh}{3}$ (B) $\pi R\sqrt{(R^2+H^2)}\rho gh$ (C) $\pi R^2\rho gh$ (D) zero

5. A cubica bock of steel of side 'ℓ' is floationg in mercury in a vessel. The densities of stee anhd mercury are ρ_s and ρ_m . The height of the bock above the mercury level is given by

(A) $\ell\left(1+\frac{\rho_s}{\rho_m}\right)$ (B) $\ell\left(1-\frac{\rho_s}{\rho_m}\right)$ (C) $\ell\left(1+\frac{\rho_m}{\rho_s}\right)$ (D) $\ell\left(1-\frac{\rho_m}{\rho_s}\right)$

6. A body floats with two – third of its volume outside water and $(3/4)^{th}$ of its volume outside the other liquid. The density of the other liquid is

(A) (9/4) gm/cc (B) 4.0 gm/cc
(C) (8/3) gm/cc (D) (4/3) gm/cc

7.A piece of wax weighs 18.03 gm in air. A piece of metal I found to weigh 17.03 gm in water. It is tied to the wax and both togther weigh 15.23 gm in water. Then, specific gravity of wax is

(A) $\frac{18.03}{17.03}$ (B) $\frac{17.03}{18.03}$ (C) $\frac{18.03}{19.83}$ (D) $\frac{15.23}{17.03}$

8. A body of ensity d_1 is balanced by a body of weight Mg and density d_2 when both the dodies are fully submerged in a liquid of density d. The true mass of the body is

(A) M (B) $\frac{M}{(1 - d/d_2)}$ (C) M $(1 - d/d_1)$ (D) $\frac{M[1 - d/d_2]}{[1 - d/d_1]}$

9. A block B of peciffic gravity and another C of specific gracity 0.5. Both are joind together an they are floating inside water such that they are completely dipped inside water, the ration of the masses of the block B and C is

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

10. Water flows steadily through a horizontal pipe of variable cross – section.If the pressure of water is ρ at a point where the velocity of flow is v. ast6 another point (pressure ρ'), where the veocity of fow in ηv: The folowing statements are given below

(A) $\frac{p'}{p} < 1$, when $\eta < 1$ (B) $\frac{p'}{p} < 1$, when $\eta > 1$

(C) $\frac{p'}{p} > 1$, when $\eta < 1$ (D) $\frac{p'}{p} > 1$, when $\eta > 1$

choose the coenct statement.

(A)(a) and (d) ae true. (B) (a) and (b) are true.

(C) (b) and (c) are true. (D) (c) and (d) are true.

11. Aio stream flows hoizontal past an aeroplane wing of surface area 4 m^2. The speed of ai over the top surface is 60 m/s and unde the bottom surface is 40 m/s. The force of lift on the wing is (Density of air = 1 kg /m^3.)

(A) 800 N (B) 1000 N (C) 4000 N (D) 3200 N

12. The height water level in a tank is 'H'. The horizontal range of a water stream coming out of a hole at a depth of H/4 from upper water level will be

(A) $\frac{\sqrt{3H}}{2}$ (B) $\frac{2H}{\sqrt{3}}$ (C) $\frac{H}{\sqrt{3}}$ (D) $\sqrt{3H}$

13. A large open tank has two holes in the wall. One is a square hoe of side L at a depth 'y' from the top and the other is a circular hole of radius 'R' at a depth 4y from the top. When the tank is completely fied with water, the quantity of water flowing out per second from each hole is the same. Then, R is equal to

(A) $\frac{L}{\sqrt{2\pi}}$ (B) 2πL (C) L (D) $\frac{L}{2\pi}$

14. In a state of weightlessness, a capillary tube is dipped in water. The water

(A) will not rise at all

(B) will rise to same height as at atmospheric pressure

(C) will rise to a height lower than at atmospheric pressure

(D) will rise to upper end of the capiary tube to any length

15. Two parallel glall plates separated by a small gap X are dipped in a liquid of surface tension T, density ρ. If the angle of contact is θ then the height upto which the liquid rises is

(A) h = 0 (B) $h = \frac{2T\cos\theta}{X\rho g}$ (C) $h = \frac{2T\cos\theta}{x}$ (D) $h = \frac{xT}{\rho gh\cos\theta}$

16. Consider a caillary dipped in a liquid in a beaker placed in a cylinder piston arrangement shown in the figure. The height of liquid coumn in capillary at pressure P_0 is h. Now if the pressure is increased isothermally then h

(A) increases (B) decreases
(C) remains same (D) nothing can be predicated

17. Aa smooth spherical ball of raduis 1 cm and density 4×10^3 kg/m^3 is dropped gently in a lage containre containing viscous liquid of density 2×10^3 kg/m^3 ,η = 0.1 N – s/m^2. The distance moved by the ball in t = 0.1 sec after it attains termianl velocity is

(A) $\frac{4}{5}$ m up (B) $\frac{4}{9}$ m up (C) $\frac{2}{3}$ m down (D) $\frac{4}{9}$ m down

18. A steel bal of aduis 2 mm is falling through glycerine. If the coefficient of viscosity of glycerine is 0.85 kg/m s, density of glycerine is $1/2 \times 10^3$ kg/m ^{3} and density of steel is 8×10^3 kg/m^3, then the terminal velocity of the ball will be

(A) 0.07 m/s (B) 7 m/s (C) 0.7 m/s (D) 70 m/s

19. A small ball rises to surface at a constant velocity in a liquid whose density is four times greater than that of the material of the bal. The ratio of viscous force acting on the rising ball and its weight is

(A) 3 : 1 (B) 4 : 1 (C) 1 : 3 (D) 1 : 4

20. Two equal drops of water are falling through air with terminal velocity oc 10 cm/sec. If the drops coaesce, then the terminal of the large drop is

(A) 10 cm/sec (B) 20 cm/sec (C) $10 \times (2)^{2/3}$ cm/sec (D) 5 cm/sec

MULTI CHOICE MULTI CORRECT

1.Plane of metal weighs 210 g in air, 180 g in water and 120 g in liquid. Then, specific gravity of

(A)Metal is 3 (B) metal is 7 (C) liquid is 3 (D) liquid is 1/3

2. A solid sphere moves with a termina velocity of 220 m/s in air at a lace where g = 9.8 m/s^2. The sphere is taken to a gravity free space having air at the same pressure and pushed down at a speed of 20 m/s.

(A) Its initial acceleration will be 9.8 m/s^2 upwards
(B) Its initial accelaration will be 9.8 m/s^2 downwards
(C) The magnitude of acceleration will decrease as the time passes
(D) The sphere will eventually stop.

3. Water is being poured into a vessel at a constant rate ………m^3/s. There is a smal aperturte of cross sectional area a at the bottom of the vesse. The maximum level of water in the vesse is proportional to

(A)………. (B) (C) 1/a (D) 1/a^2

4. When a capillary tube is dipped in a liquid, the liquid rises to a height h in the thew tube. The free liquid suface inside the tube is hemispherical in shape. The tube is now pushed down so that the height of the tube outside the liquid is less than h.
(A) The liqui will ooze out of the tube slowly.
(B) The liquid wi come out of the tube like in a small fountain.
(C) The free liquid surface inside the tube will not be hemispherical.
(D) The liquid will fill the tube but not come out of its upper end.

NUMERICAL BASED TYPE

1. A solid uniform ba havinmg volume V and density ρ (= 2×10^3 kg/m^3)
Floats at the interface of two immicibe liquid as shown in the figure. The denitie of the upper and the ower liquids are ρ_1 (= 1.5×10^3 kg/m^3) and (ρ_2 = 2.5×10^3 kg/m^3) respectivey. The fraction of the volume of the ball in the upper liquid is 1/x. Then is equal to
2.Equal volume of two immecibe liquids of densities ρ and 2ρ are filled in a vessel as shown. Two small hole are drilled at depths h/2 and 3h/2 from the urface of the lighter liquid. If v_1 and v_2 are the speed of efflux at these two holes,then $\binom{v_{22}}{v}$ is
1

3.When liquid medicine of density ρ is be put in the eyes, it is done with the halp of a dropper. As the bulb on the top of the dropper is pressed, a drop froms at the opening of the fropper. We wish to etimate the ize of the drop. We first assume that the drop formed at the opening is spherical because that requires a minimum increase in it surface energy. To determine the ize, we calculate the net vertical force due to the urface tension T when the radius of the drop is R. When the force become smaller than the weight of the drop, the drop detss detached from the dropper. If r = 5×10^{-4} m, $\rho = 10^3$ kg m^{-3}, g = 10 m/s^2, T – 0.42 Nm^{-1}, the radiu of the drop when it detaches from the dropper is approximately in mm.

4. Two spheres of the same material but of radii 0.01 and 0.02 m are dropped one by one in the same viscous fluid. Their terminal velocitie respectively will in the ratio.

LINKED COMPREHENSION TYPE

Figure shows a siphon in action. A siphon is very convenient for removing liquid from containers. But necessary condition for its working is that the liquid removing tube must be filled completely with the liquid so thet there could be pressure difference along the tube. If there is no liquid, pressure at all points has the same value and so liquid wi not flow. The liquid shown in the figure is water having density of 1000 kg/m^3. Both the liquid containers are open to atmosphere. Al the heights are shown in the figure. The end D of pipe is above wate level in the container.
Take g = 10 m/s^2
1.Find the pressure difference between points B and C.
(A) zero (B) 1.5×10^4 N/m^2 (C) 1.25×10^4 N/m^2 (D) 10^4 N/m^2
2. Find the speed of the liquid through the siphon tube.
(A) √30 m/s (B) 5 m/s (C) √10 m/s (D) zero
3. If the height h of AB is varied such that the flow of the liquid stops. Then find the minimum vaue of the height h.
(A) 10.2 m (B) 0.5 m (C) 1.75 m (D) 13.6 m

MATRIX – MATCH TYPE

Each question contains statements gives in two columns which have to be matched. Statenents(A, B, C, D) in column I have to be matched with statements (p, q, r, s) in column II.

COLUMN – I	COLUMN – II
(A)Adhesive forces is greater than cohesive force.	
(B) Cohesive forces is greater than adhesive forces.	
(C) pressure at A > pressure at B	
(D) pressure at B > pressure at A	

SECTION – II

1.In the following diagrams three different liquids have been taken in three beakers and a ball make of a material of specific gravity D remain in these three liquids as shown. If the three liquids X, Y, Z have specific gravities D_x, D_y and D_z respectively, which of the following statemnt is correct?

(A) $D_x > D_y > D_z$ (B) $D_z < D_y > D_x$ (C) $D_y > D_x > D_Z$ (D) $D_x > D_z > D_y$

…………………….

2.A cubical block is floating in a liquid with half of its vollume immersed in the liquid. When the whole system acceerates downward with an acceerationh g/3. The fraction of volume immersed in liquid will be

(A) 1/2 (B) 3/8 (C) 2/3 (D) 3/4

3. Araft of wood (density 600 kg/m^3) of mass 129 kg flots in water. How much weight can be ut on the raft to make it just sink?

(A) 120 kg (B) 200 kg (C) 40 kg (D) 86 kg

4. A vessel containing liquid is being accelerated in the horizontal plane. The surface of the liquid is making an angle of 30^o with the horizontal. The acceleration of the vessel is

(A) $\frac{g}{\sqrt{3}}$ (B) $\frac{g}{4}$ (C) $\frac{2g}{\sqrt{3}}$ (D) $\frac{g}{2}$

5. A metallic sphere floats in immisible mixture of water (density 10^3 kg/m^3) and a liquid (density 8×10^3 kg/m^3) such that its (2/3) part is in water and (1/3) part in the liquid. The density of the metal is

(A) $\frac{5000}{3} kg/m^3$ (B) $\frac{10000}{3} kg/m^3$ (C) 5000 kg/m^3 (D) 2000 kg/m^3

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

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

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

(C) The balance A will read less than 2 kg and B will read more than 5 kg.

(D) The balance A and B will read 2 kg and 5 kg respectively.

7. In the given figure, the velocity v_3 will be

(A) zero

(B) 4 m/sec.

(C) 1 m/sec.

(D) none of these

8. Water has been filled in a conical vessel fixed on the horizontal surface at it base. When very small hoe made in it curved surface as shown in the figure, water will come out in which of the direction shown

(A) 1 (B) 2 (C) 3 (D) 4

9. An incompressible non – viscous (density ………) flows steadily through a cylindrical pipe which has radius 2R at point A and radius R at point B (at the same height as A) further along the flow direction. If the velocity and pressure at point A are V and P respectively, the pressure at B will be

(A) p - $\frac{1}{2}$…….V^2 (B) P – 8………….V^2 (C) P + 2…..V^2 (D) P – 7.5 …..V^2

10. A cylindrical vessel contains a liquid of density ρupto a height h. A frictionless piton of mass m and area of cross section A is in contact with the upper surface of the liquid. There is a small hole at the bottom of the vessel. The speed with which liquid comes out of the hole is

(A) $(2gh)^{1/2}$ (B) $[2g(h + m/\rho A]^{1/2}$

(C) $[2g(h + m/A)^{1/2}$ (D) $[2gh + mg/\rho A]^{1/2}$

11. In the venturimeter as shown, water is flowing speed at x is 2 cm/sec. The speed of water at
($g = 1000 cm/s^2$)

(A) 23 cm/sec

(B) 32 cm/sec

(C) 101 cm/sec

(D) 1024 cm/sec

12. As shown in the figure, find the velocity of water flow ρ_1 and ρ_2 are densities of water and kerosene respectively.

(A) $v = \sqrt{2g}\,(h_1 + h_2)$ (B) $v = \sqrt{2g}\,(h_1\rho_1 + h_2\rho_2)$

(C) v = …………………… (D)…………….

13. In the given situation what should be the minimum horizontal acceleration given to the vessel so that liquid does not come out of the hole. When it is open?

(A) g (B) $g(H/\ell)$ (C) $g(2h/\ell)$ (D) $g(H – h)/\ell$

14. A rectangular tank is filled completely with water. A hole at its bottom is unplugged. The graph between the velocity of efflux (through a small hole) v_s depth of water h form the top of tank.

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

15. Water flows out of the hole on the side of a bucket and follows a parabolic path. If the bucket falls freely under gravity, ignoring air resistance, the water flow

(A) follows a straight line path relative the falling bucket

(B) follows a parabolic path relative the falling bucket

(C) decreases but continuous to flow

(D) stops

16. If a section of a soap bubble of radius r by a pane through its center is considered, the force on one half due to surface tension is

(A) $2\pi rT$ (B) $4\pi rT$ (C) $\pi r^2 T$ (D) $2rT$

17. A very narrow capillary tube record a rise of 0 cm when dipped in water. When the area of cross-section is reduced to one-fourth of the former value, water will rise to a height of

(A) 10 cm (B) 20 cm (C) 40 cm (D) 80 cm

18.If two soap bubbles of different radii are in communication with each other

(A) air flows from the large bubble into the smaller one until the two bubble are of equal size.

(B) size of bubbles remains unchanged.

(C) air flows from the smaller bubble into the larger bubble grows at the expense of the smaller one.

(D) size will be exchanged.

19. The terminal velocity v_r if a small steel ball of radius falling under gravity through a column of a viscous fluid of coefficient of viscosity η depends on mass m of the ball, acceleration due to gravity g and radius r. Which of the following relation is dimensionally correct?
(A) (B) (C) (D)

20. Two spheres of the same material but of radii 0.01 and 0.2 m are dropped one by one in the same viscous fluid. Their terminal velocities respectively will be in the ratio
(A) 1 : 1 (B) 1 : 2 (C) 1 : 4 (D) 4 : 1