Mechanical Properties of Fluids Important Questions With Answers

NEET Physics 2023

1. A capillary tube of radius r is immersed in water and water rises in it to a height h. The mass of the water in the capillary is 5 g. Another capillary tube of radius 2 r is immersed in water. The mass of water that will rise in this tube is_____

   a) $2.5 \mathrm{~g}$ b) $5.0 \mathrm{~g}$ **c)** $10.0 \mathrm{~g}$ d) $20.0 \mathrm{~g}$

   Solution : -

   m a r

   $\frac{m_2}{m_1}=\frac{r_2}{r_1}$

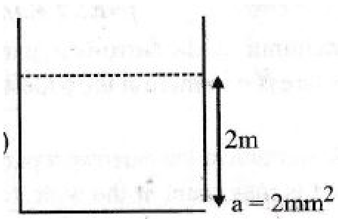
   $\frac{m_2}{5}=\frac{2r}{r}$

   $m_2=10 \mathrm{~g}$

2. A small hole of area of cross-section $2 \mathrm{~mm}^2$ is present near the bottom of a fully filled open tank of height 2 m. Taking $g=10 \mathrm{~m}/\mathrm{s}^2$, the rate of flow of water through the open hole would be nearly____

   a) $8.9 \times 10^{-6} \mathrm{~m}^3/\mathrm{s}$ b) $2.23 \times 10^{-6} \mathrm{~m}^3/\mathrm{s}$ c) $6.4 \times 10^{-6} \mathrm{~m}^3/\mathrm{s}$ **d)** $12.6 \times 10^{-6} \mathrm{~m}^3/\mathrm{s}$

   Solution : -

   Rate of flow liquid

   $\mathrm{Q}=au-a\sqrt{2\mathrm{gh}}$

   $=2 \times 10^{-6} \mathrm{~m}^2 \times \sqrt{2 \times 10 \times 2} \mathrm{~m}/\mathrm{s}$

   $=2 \times 2 \times 3.14 \times 10^{-6} \mathrm{~m}^3/\mathrm{s}$

   $=12.56 \times 10^{-6} \mathrm{~m}^3/\mathrm{s}$

   $=12.6 \times 10^{-6} \mathrm{~m}^3/\mathrm{s}$

3. A soap bubble, having radius of 1 mm, is blown from a detergent solution having a surface tension of $2.5 \times 10^{-2} \mathrm{~N}/\mathrm{m}$. The pressure inside the bubble equals at a point Z below the free surface of water in a container. Taking $\mathrm{g}=10 \mathrm{~m}/\mathrm{s}^2$, density of water $=10^3 \mathrm{~kg}/\mathrm{m}^3$, the value of Z_0 is____

   a) 10 cm **b) 1 cm** c) 0.5 cm d) 100 cm

   Solution : -

   Excess pressure $=\frac{4 \mathrm{~T}}{\mathrm{R}}$, Gauge pressure $=\mathrm{rg}\, Z_0$

   $\mathrm{P}_0+\frac{4 \mathrm{~T}}{\mathrm{R}}=\mathrm{P}_0+\rho_g \mathrm{Z}_0$

   $\mathrm{Z}_0=\frac{4 \mathrm{~T}}{\mathrm{R} \times \rho g}$

   $Z_0=\frac{4 \times 2.5 \times 10^{-2}}{10^{-3} \times 1000 \times 10} \mathrm{~m}$

   $\mathrm{Z}_0=1 \mathrm{~cm}$

4. Three liquids of densitites $\mathrm{r}_1, \mathrm{r}_2$ and r_3 (with $\mathrm{r}_1 > \mathrm{r}_2 > \mathrm{r}_3$), having the same value of surface tension T, rise to the same height in three identical capillaries. The angle of contact $\mathrm{q}_1, \mathrm{q}_2$ and q_3 obey____

a) $\frac{\pi}{2} > \theta_1 > \theta_2 > \theta_3 \geq 0$ **b)** $0 \leq \theta_1 > \theta_2 > \theta_3 < \frac{\pi}{2}$ c) $\frac{\pi}{2} < \theta_1 > \theta_2 > \theta_3 \geq \pi$

d) $\pi > \theta_1 > \theta_2 > \theta_3 \geq \frac{\pi}{2}$

Solution : -

For Capillary tube, by the ascent formula

$h = \frac{2T\cos\theta}{\rho g r}$

$\therefore \frac{\cos\theta_1}{\rho_1} = \frac{\cos\theta_2}{\rho_2} = \frac{\cos\theta_3}{\rho_3}$

Thus, $\cos\theta\alpha\rho$

$\therefore \cos\theta_1 > \cos\theta_2 > \cos\theta_3$

$0 \leq \theta_1 < \theta_2 < \theta_3 < \frac{\pi}{2}$

5. A wind with speed $40\ \mathrm{m/s}$ blows parallel to the roof of a house. The area of the roof is $250\ \mathrm{m}^2$. Assuming that the pressure inside the house is atmospheric pressure, the force exerted by the wind on the roof and the direction of the force will be $\left(\mathrm{P}_{\text{air}} = 1.2\ \mathrm{kg/m}^3\right)$____

a) 4.8×10^5 N,upwards **b) 2.4×10^5 N,upwards** c) 2.4×10^5 N,downwards d) 4.8×10^5 N,downwards

Solution : -

By Bernoulli's theorem, we have

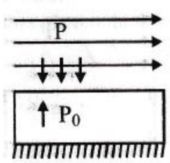
$P + \frac{1}{2}\rho v^2 = P_0 + 0$

So, $\Delta P = \frac{1}{2}\rho v^2$

$F = \Delta P A = \frac{1}{2}\rho v^2 A$

$= \frac{1}{2} \times 1.2 \times 40 \times 40 \times 250$

$= 2.4 \times 10^5\ \mathrm{N}(\text{ upwards })$



6. A certain number of spherical drops of a liquid of radius 'r ' coalesce to form a single drop of radius ' R' and volume ' V . If ' T ' is the surface tension of the liquid, then___

a) energy $= 4VT\left(\frac{1}{r} - \frac{1}{R}\right)$ is released b) energy $= 3VT\left(\frac{1}{r} + \frac{1}{R}\right)$ is absorbed

c) energy $= 3VT\left(\frac{1}{r} - \frac{1}{R}\right)$ is released d) energy is nèither released nor absorbed

Solution : -

After decrease in surface area, energy is released. Energy released $= 4\pi R^2 T\left[n^{1/3} - 1\right]$

where $R = n^{1/3} r$

$= 4\pi R^3 T\left[\frac{1}{r} - \frac{1}{R}\right] = 3VT\left[\frac{1}{r} - \frac{1}{R}\right]$

7. A fluid is in streamline flow across a horizontal pipe of variable area of cross section. For this which of the following statements is correct?

a)

The velocity is maximum at the narrowest part of the pipe and the pressure is maximum at the widest part of the pipe

b) Velocity and pressure both are maximum at the narrowest part of the pipe

c) Velocity and pressure both are maximum at the widest part of the pipe

d)

The velocity is minimum at the narrowest part of the pipe and pressure is minimum at the widest part of the pipe

Solution : -

As per Bernoulli's theorem, $P+\frac{1}{2}PV^2=$ constant and Av = constant
If A is minimum, v is maximum, P is minimum.

8. The wetability of a surface by a liquid depends primarily on_____
   a) surface tension b) density **c) angle of contact between the surface and the liquid** d) viscosity

   Solution : -
   Wetability of a surface by a liquid primarily depends on angle of contact between the surface and liquid.
   If angle of contact is acute, liquids wet the solid and vice-versa.

9. A rectangular block of mass m and area of cross section A floats in a liquid of density r. If it is given a small vertical displacement from equilibrium it undergoes oscillation. with a time period T. Then_____
   a) $T\alpha\frac{1}{\sqrt{A}}$ b) $T\times\frac{1}{\rho}$ c) $T,\alpha\frac{1}{\sqrt{m}}$ d) $T\alpha\sqrt{\mathrm{p}}$

   Solution : -
   Suppose the body is pushed by distance x from its equilibrium position. The extra upthrust created is xrAg which act on the whole body.
   If a be acceleration developed then,
   $x\rho Ag=ma\Rightarrow a=\frac{\rho Ag}{m}x$
   since, acceleration proportional x, so it is equation of S.H.M.
   So, $\omega^2=\frac{\rho Ag}{m}\Rightarrow T=2\pi\sqrt{\frac{m}{\rho Ag}}\Rightarrow T\alpha\frac{1}{\sqrt{A}}$

10. The angle ofcontact between pure water and pure glass is_____
    a) 0^o b) 45^o c) 90^o d) 135^o

    Solution : -
    The angle of contact is the angle between the tangent to liquid surface at the point of contact and solid surface inside the liquid. In case of pure water and pure glass, the angle of contact is zero.

11. In rising from the bottom of a lake, to the top, the temperature of an air bubble remains unchanged, but its diameter gets doubled. If h is the barometric height ^{3} (expressed in m of mercury of relative density r) at the surface of the lake, the depth of the lake is_____
    a) $8\rho hm$ **b)** $7\rho hm$ c) $9\rho hm$ d) $12\rho hm$

    Solution : -
    $(h\rho g+H\times1\times g)\frac{4}{3}\pi r^3=h\rho g\times\frac{4}{3}\pi(2r)^3$
    $\Rightarrow h\ell g+Hg=8H\ell g$
    $\Rightarrow H=7h\rho m$

12. The terminal velocity v_r of a small steel ball of radius r falling under gravity through a column of a viscous liquid of coefficient of viscosity h and radius r. Which of the following relations is dimensionally correct?
    a) $v_r\alpha\frac{mgr}{\eta}$ b) $v_r\alpha mg\eta_r$ **c)** $v_r\alpha\frac{mg}{r\eta}$ d) $v_r\alpha\frac{\eta mg}{r}$

    Solution : -
    According to stoke's law, we have
    $6\pi\mathrm{h}rv_r=mg$
    Hence, the valid relation is $v_r\alpha mg/rn$

13. An ice block with relative density 0.9 floats in water (density=1.0 g/cc). A part of block is outside water level. When the ice block has completely melted, the water level will
    a) rise b) fall **c) remain same** d) it will depend on mass of block

    Solution : -
    As, ice block is floating, the mass of water displaced by ice is equal to the mass of ice. As the ice would melt, it would convert into water. This water will occupy the same mass as it was originally displaced by the ice in water. So, no change in volume would take place i.e., the water level will remain same.

14. A piece of iron has weight win air, w_1 when immersed completely in water and w_2 when immersed completely in a liquid. The relative density of liquid is

a) $\frac{w_1-w_2}{w-w_1}$ b) $\frac{w_1-w_2}{w-w_2}$ c) $\frac{w-w_1}{w-w_2}$ **d)** $\frac{w-w_2}{w-w_1}$

Solution : -

Net weight in water,

$w-w_1=V\rho_w g$ = Buoyant force ......(i)

Net weight in liquid,

$w-w_2=V\rho_1 g$ =Buoyant force .....(ii)

$\therefore\ \frac{w-w_2}{w-w_1}=\frac{\rho_l}{\rho_w}$ =Relative density of liquid

15. In absence of gravity, which of the following will not be there for a fluid?

a) Viscosity b) Surface tension c) Pressure **d) Archimedes' upwards thrust**

Solution : -

If there is no gravity, Archimedes' upwards thrust will be absent for a fluid.

16. A body is just floating in a liquid. Both have same densities (i.e., body and liquid). If body is slightly pressed down and then released it will

a) oscillate **b) sink down** c) come back to same position instantaneously

d) come back to same position slowly

Solution : -

As the weight of the body is equal to upthrust, then the body will sink due to downward push.

17. Along streamline,

a) the velocity of all fluid particles at a given instant is constant

b) the speed of a fluid particle remains constant c) the velocity of a fluid particle remains constant

d) velocity of all fluid particles crossing a given position is constant.

Solution : -

Along any streamline, the velocity of particles at different positions on a particular streamline may be different, but the velocities of all the particles crossing any particular point is always remains same.

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

a) Speed is low at wider end b) Speed is high at narrow end **c) Both (a) and (b) are correct**

d) None of the above

Solution : -

From the equation of continuity,

Av = constant

$\Rightarrow \quad A\propto\frac{1}{v}$

Speed is low at wider end and high at narrow end.

19. An ideal fluid flows through a pipe of circular cross - section mad of two sections with diameters 2.5 cm and 3.75 cm. The ratio of velocities in the two pipes is

a) $9:4$ b) $3:2$ c) $\sqrt{3}:\sqrt{2}$ d) $\sqrt{2}:\sqrt{3}$

Solution : -

Equation of continuity, $A_1V_1 = A_2V_2$

$$\Rightarrow\frac{v_1}{v_2}=\frac{A_2}{A_1}=\frac{\pi d_2^2}{\pi d_1^2}\Rightarrow\frac{v_1}{v_2}=\frac{(3.75)^2}{(2.50)^2}=\frac{9}{4}$$

20. A sphere of mass m falls through a viscous fluid with the terminal velocity v. Then, the terminal velocity of another sphere curved out of same material but mass 27 m is

a) 3v b) 6v c) 27v **d) 9v**

Solution : -

If r is the radius of small sphere and R is the radius of big sphere, then
$\frac{4}{3}\pi R^3 \times \rho = 27 \times \frac{4}{3}\pi r^3 \times \rho \quad \Rightarrow \quad R = 3r$
Now, terminal velocity $v \propto r^2$
$\therefore \frac{V_R}{V} = \left(\frac{R}{r}\right)^2 = 9 \quad \Rightarrow \quad V_R = 9v$

21. When a number of small droplets combine to form a large drop, then
a) energy is released b) energy is absorbed c) cannot be predicted
d) process does not involve any energy change

Solution : -
When many small droplets combine to form a bigger drop, energy is released as its surface area gets decreased.

22. A mercury drop of radius 10 cm is broken in 10^3 drops of equal size. The work done of equal size. The work done required in this process is (S=40X10^{-2} N/m)
a) 0.45 J b) 0.9 J c) 0.38 J d) 0.72 J

Solution : -
If r is the radius of the small droplets, then
$\frac{4}{3}\pi r^3 \times 10^3 = \frac{4}{3}\pi \times (10)^3 \Rightarrow r = \left(\frac{10^3}{10^3}\right)^{1/3} = 1cm \quad or \quad 10^{-2}m$
Work done = Surface tension x Increase in area
= $40 \times 10^{-2} \times \left[10^3 \times 4\pi\left(10^{-2}\right)^2 - (0.1)^2\right] = 0.452J$

23. A capillary is immersed in water in the absence of gravity. The water will
a) rise to maximum height available b) rise to a height same as in presence of gravity c) not rise at all
d) rise to a height lesser than that observe under gravity

Solution : -
In the absence of gravity, water in capillary will have only upwards force and as such water will rise upto the maximum available height.

24. A liquid drop of radius R breaks into N smaller droplets of radii r. If liquid has density ρ , specific tension T, then the drop in temperature is given by
a) $\frac{NT}{\rho S}\left(\frac{1}{R} - \frac{1}{r}\right)$ b) $\frac{NT}{\rho S}\left(\frac{R}{r} - 1\right)$ c) $\frac{3}{4}\frac{T}{\rho S}\left(\frac{1}{R} - \frac{1}{r}\right)$ **d)** $\frac{3T}{\rho S}\left(\frac{1}{R} - \frac{1}{r}\right)$

Solution : -
V olume will remain same, hence we can write
$\frac{4}{3}\pi R^3 = N \times \frac{4}{3}\pi r^3 \Rightarrow N = \frac{R^3}{r^3}$
Increase in surface energy due to breaking of drop into N droplets,
$\Delta U = 4\pi T(R^2 - Nr^2)$
As this energy is provided at the cost of lowering of temperature by $\Delta\theta$
$ms\Delta\theta = \Delta U$
$\Rightarrow \Delta\theta = \frac{\Delta U}{ms} = \frac{4\pi T\left(R^2 - Nr^2\right)}{\left(\frac{4}{3}\pi R^3\rho\right)S}$
$\Rightarrow \Delta\theta = \frac{3T}{\rho S}\left(\frac{1}{R} - \frac{r^2}{R^3}N\right) = \frac{3T}{\rho S}\left(\frac{1}{R} - \frac{1}{r}\right) \quad \left(\because N = \frac{R^3}{r^3}\right)$

25. A water drop of 0.01 cm^3 is squeezed between the two glass plates and spread into an area of 20 cm^2 . If surface tension of water is 7X10^{-2} N/m, the normal force required to separate the glass plates from each other will be
a) 56 N b) 28 N c) 36 N d) 72 N

Solution : -

If F is the force applied to separate the plates, then work done by this force is infact used in creating the new surfaces, in the form of surface energy. As two surfaces are created, the surface energy required would be 2SA, where S is surface tension of water. If t is the separation when liquid losses contact, then work done would be Fx t.

Thus, F x t = 2SA

$$\Rightarrow \quad F = \frac{2SA}{t} \times \frac{A}{A} = \frac{2SA^2}{Volume \quad of \quad drop}$$

$$\Rightarrow \quad F = \frac{2\times7\times10^{-2}\times\left(20\times10^{-4}\right)^2}{\left(0.01\times10^{-6}\right)} = 56N$$

26. A body of density ρis dropped from height h into a liquid having density σ $(\sigma > \rho)$. If the body just touches the base of the container, then the depth of the container would be proportional to (Neglect viscous forces)

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

Solution : -

Buoyant force, $F \propto (\sigma - \rho)$

$\therefore$ Deceleration $\propto (\sigma - \rho) \Rightarrow a = -k(\sigma - \rho)$

Now, as initial velocity $u = \sqrt{2gh}$

and final velocity, v = 0

Using, $v^2 - u^2 = 2as$ ($\because$ Newton's 3rd Eq of Motion)

$\Rightarrow s = \frac{u^2}{2a} \Rightarrow s = \frac{2gh}{2\times k(\sigma-\rho)}$

i.e., $s \propto \frac{h}{\sigma-\rho}$

27. A block of mass m and density ρis hanging from a string. If it is lowered into a vessels of cross - sectional area A containing a liquid of density $\sigma(< \rho)$ and gets fully immersed, the increase in pressure at the bottom of vessel would be

a) $\frac{m\rho g}{\sigma A}$ **b)** $\frac{m\sigma g}{\rho A}$ c) $\frac{mg}{A}$ d) $zero$

Solution : -

Volume of block = $\frac{m}{\rho}$

$\therefore$ Buoyant force on block = Volume x Density of liquid x g

= $\frac{m}{\rho}$ x σ x g

By Newton's third law of motion, force exerted by block on liquid surface = $\frac{m\sigma g}{\rho}$

$\therefore$ Increase in pressure = $\frac{m\sigma g}{\rho A}$

28. A closed tank has pressure, P=3 atm some point O on the tank. If tank is ruptured at this point to make a small hole, the velocity of efflux through the hole is (1 atm = 10^5 N/m^2)

a) 10 m/s b) 15 m/s **c) 20 m/s** d) 30 m/s

Solution : -

Pressure in excess of atmospheric pressure at point O is

$p' = p - p_o$ = 3atm - 1atm

= 2atm = 2 x 10^5 N/m^2

This closed tank will act as an open tank of height h given by

hρ g = 2 x 10^5

i.e., h x 1000 x 10 = 2 x 10^5 $\Rightarrow$ h=20m

Therefore, velocity of efflux, v = $\sqrt{2gh}$

= $\sqrt{2 \times 10 \times 20} = 20m/s$

29. Wooden ball of density ρ is immersed in a liquid of density ρ' to a depth h below the surface of water and then released. The height to which the ball will come out of water is

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

Solution : -

If V is the volume of the ball.

Net upthrust on ball = $V\rho' g - V\rho g$

$\therefore$ Upward acceleration a = $\frac{V\rho' g-V\rho g}{V\rho} = \left(\frac{\rho'-\rho}{\rho}\right)g$

Velocity of ball on reaching surface, v = $\sqrt{2ah}$

If ball rises through height H outside liquid $V = \sqrt{2gH}$

$\therefore \sqrt{2ah} = \sqrt{2gH} \Rightarrow H = \frac{ah}{g} = \left(\frac{\rho'-\rho}{\rho}\right)\frac{gh}{g} = \left(\frac{\rho'}{\rho}-1\right)h$

30. An ice cube containing a stone inside it, is floating in water contained in a flask. The position of the level of water in the flask, when the whole ice melts, will be

a) less than before b) greater than before c) remain same d) None of the above

Solution : -

Let m_1 = mass of ice, m_2 = mass of stone

ρ = density of water

$\therefore$ Volume of water displaced by an ice cube is

$V = \left(\frac{m_1+m_2}{\rho}\right) = \frac{m_1}{\rho} + \frac{m_2}{\rho}$

When ice melts increase in volume of water = $\frac{m_1}{\rho}$

When stone sinks V' displaced water = $\frac{m_2}{\rho_{stone}}$

$\therefore$ Total volume (new) = $\frac{m_1}{\rho} + \frac{m_2}{\rho_{stone}} = V'$

Now, as $\rho_{stone} > \rho$

$\therefore$ V' < V

i.e., Level of water will decrease

31. A body has weight W_1 in liquid of density ρ_1 and W_2 in a liquid of density ρ_2. The weight of the body in a liquid of density ρ_3 is

a) $\frac{w_2(\rho_3-\rho_1)-w_1(\rho_3-\rho_2)}{\rho_2-\rho_1}$ b) $\frac{w_1(\rho_3-\rho_1)-w_2(\rho_3-\rho_2)}{\rho_2-\rho_1}$ c) $\frac{w_1(\rho_3-\rho_1)-w_2(\rho_2-\rho_3)}{\rho_1-\rho_2}$ d) $\frac{w_1(\rho_1-\rho_3)-w_3(\rho_2-\rho_3)}{\rho_2-\rho_1}$

Solution : -

Weight, w = mg and density, $\rho = \frac{m}{V}$

$\therefore$ Weight of body when immersed in a liquid of density ρ_1 ,would be

$w_1 = mg - V\rho_1 g = mg - \frac{m}{\rho}\rho_1 g = w\left(1-\frac{\rho_1}{\rho}\right) \quad \ldots(i)$

Similarly, $w_2 = w\left(1-\frac{\rho_2}{\rho}\right) \quad \ldots(ii)$

and $w_3 = w\left(1-\frac{\rho_3}{\rho}\right) \quad \ldots(iii)$

Solving Eqs. (i), (ii) and (iii), we get

$w_3 = \frac{w_2(\rho_3-\rho_1)-w_1(\rho_3-\rho_2)}{\rho_2-\rho_1}$

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

a) $\frac{\rho L}{T}$ b) $\sqrt{\frac{T}{\rho L}}$ c) $\frac{T}{\rho L}$ **d)** $\frac{2T}{\rho L}$

Solution : -
When radius is decreased by dr.
Decrease in surface energy = Heat required for vaporization
$(4\pi r dr) \times T \times 2 = 4\pi r^2 dr \rho \Rightarrow r = \frac{2T}{\rho L}$

33. Water is flowing continuously from a tap having an internal diameter of 8$\times$ 10^{-3} m. The water velocity as it leaves the tap is 0.4 ms^{-1} . The diameter of the water stream at a distance 2X10^{-1} m below the tap is close to
a) 7.5X10^{-3} m b) 9.6X10^{-3} m **c) 3.6X10^{-3} m** d) 5.0X10^{-3} m

Solution : -
From Bernoulli's theorem,

$$\rho g h = \frac{1}{2}\rho\left(v_2^2 - v_1^2\right) \quad \Rightarrow \quad gh = \frac{1}{2}v_1^2\left[\left(\frac{v_2}{v_1}\right)^2 - 1\right]$$

$$\Rightarrow \quad gh = \frac{1}{2}v_1^2\left[\left(\frac{A_1}{A_2}\right)^2 - 1\right] \quad (\because A_1 v_1 = A_2 v_2)$$

$$\Rightarrow \quad \left(\frac{A_1}{A_2}\right)^2 = 1 + \frac{2hg}{v_1^2} \Rightarrow \left(\frac{D_1}{D_2}\right)^4 = 1 + \frac{2gh}{v_1^2}$$

$$\Rightarrow \quad D_2 = \frac{D_1}{\left(1+\frac{2hg}{v_1^2}\right)^{1/4}} = \frac{8\times10^{-3}}{\left(1+\frac{2\times10\times0.2}{(0.4)^2}\right)^{1/4}}$$

$$= 3.6 \times 10^{-3} m$$

34. Two mercury drops (each of radius r) merge to form a bigger drop. The surface energy of the 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)** $2^{8/3}\pi r^2 T$

Solution : -
Let R be the radius of the bigger drop, then Volume of bigger drop = 2 x volume of small drop

$$\frac{4}{3}\pi R^3 = 2 \times \frac{4}{3}\pi r^3 \Rightarrow R = 2^{1/3} r$$

Surface energy of bigger drop

$$E = 4\pi R^2 T = 4 \times 2^{2/3}\pi r^2 T = 2^{8/3}\pi r^2 T$$

35. If a ball of steel (density $\rho = 7.8g$ cm^{-3}) attains a terminal velocity of 10 cms^{-1} when falling in a tank of water (coefficient of viscosity $\eta_{water} = 8.5 \times 10^{-4}$ Pa -s) then, its terminal velocity for glycerine $(\rho = 12gcm^{-3}, \eta = 13.2Pa - s)$ would be nearly
a) 1.6X10^{-5} cms^{-1} **b) 6.25X$10^{-4}$$cms^{-1}$** c) 6.45X$10^{-4}$$cms^{-1}$ d) 1.5X$10^{-5}$$cms^{-1}$

Solution : -

$$v \propto \frac{\rho - \rho_0}{\eta}$$

$$\therefore \quad \frac{v_2}{v_1} = \frac{\rho - \rho_{02}}{\rho - \rho_{01}} \times \frac{\eta_1}{\eta_2}$$

$$\frac{7.8-1.2}{7.8-1} \times \frac{8.5\times10^{-4}\times10}{13.2} = 6.25 \times 10^{-4} cms^{-1}$$

36. A spherical solid ball of volume V is made of a material of density ρ_1 . It is falling through a liquid 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, i.e., $F_{viscous}$= -Kv^2(K>0)]. The terminal speed of the ball is
a) $\sqrt{\frac{Vg(\rho_1 - \rho_2)}{k}}$ b) $\frac{Vg\rho_1}{k}$ c) $\sqrt{\frac{Vg\rho_1}{k}}$ d) $\frac{Vg(\rho_1 - \rho_2)}{k}$

Solution : -
The forces acting on the ball are gravity force, buoyancy force and the viscous force. When ball acquires terminal speed, it is in dynamic equilibrium, if the terminal speed of ball is V_T.

$$v\rho_2 + kv_T^2 = v\rho_1 g \quad or \quad v_T = \sqrt{\frac{v(\rho_1 - \rho_2)g}{k}}$$

37. The terminal speed of a sphere of gold (density=19.5 kg m^{-3}) is 0.2 ms^{-1} in a viscous liquid (density=1.5kg m^{-3}). The terminal speed of a sphere of silver (density = 10.5 kg/m^3) of the same size in the same liquid will be
a) 0.4 ms^{-1} b) 0.133 ms^{-1} **c) 0.1 ms^{-1}** d) 0.2 ms^{-1}

Solution : -

Terminal speed of a spherical body in a viscous liquid is given by,

$V_T = \frac{2r^2(\rho-\sigma)g}{9\eta}$

(where ρ= Density of body and σ = Density of liquid)

From above equation, $\frac{V_T(Ag)}{V_t(Gold)} = \frac{\rho_{Ag}-\sigma_l}{\rho_{Gold}-\sigma_l}$

$\Rightarrow V_T(Ag) = \frac{10.5-1.5}{19.5-1.5} \times 0.2 = \frac{9}{18} \times 0.2 = 0.1ms^{-1}$

38. The angle between viscous force and direction of flow is
a) 90^0 **b) 180^0** c) 0^0 d) 360^0

39. Hot Syrup flows faster because it has
a) higher surface tension **b) lower viscosity** c) higher viscosity d) higher terminal velocity

40. We have three beakers A,B,C containing glycerine water and kerosene respectively.They stirred vigorously and placed on a table.The liquid which comes to rest at the earliest is
a) glycerine b) water c) kerosene d) all of them at the same time

41. Velocity of liquid above which the flow becomes turbulent is called
a) terminal velocity **b) critical velocity** c) Velocity gradient d) none of the above

42. A liquid is flowing uniformly. The net external force causing the liquid to flow is
a) equal to viscosity b) more than viscosity c) less than viscosity d) not related to viscosity

43. Two light balls are suspended with light string very close to each Other. What happens When we blow between the balls?
a) They come together b) they go apart
c) both of them will move in the same direction at right angle to the speed of air d) they will be unaffected

44. The velocity of falling rain drop attains limiting value because of
a) upthrust of air **b) viscous force exerted by air** c) surface tension effects
d) air currents in atmosphere

45. The terminal velocity of a sphere moving through a viscous medium is
a) Directly proportional to viscosity b) Inversely proportional to viscosity
c) Directly proportional to the square of the radius of sphere
d) Inversely proportional to the square of viscosity

46. If a small sphere is let fall vertically in a quantity of still liquid of density than the material of the sphere
a) At first its velocity increases, but approaches a constant value
b) It falls with a constant velocity all along from the very beginning
c) At first it falls with a constant velocity which after some time goes on decreasing
d) Nothing can be said about its motion

47. A small sphere of mass m is dropped from a great height.After it has fallen 100 metres, 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 metres of fall is:
a) Greater than the work done by air friction in the second 100 metres
b) Less than the work done by air friction in the second 100 metres c) Equal to 100 mg
d) Greater than 100 mg

48. A spherical body falling through a viscossus liquid of infinite extent ultimately attains a constant value, when:

a) Upthrust + weight = viscous drag b) Weight + viscous drag upthrust
c) Viscous drag + upthrust = weight d) Viscous drag + upthrust > weight

49. A solid sphere falls with a terminal velocity of 10cm/sec in air. If it is allowed to fall in vacuum, the terminal velocity Will
a) Be equal to 10cm/sec b) Be less to 10cm/sec c) Be more than 10 cm/sec **d) Never be attained**

50. A cylindrical vessel, half filled with kerosene takes 10 minutes to get emptied from a hole at the bottom Of the vessel. The time taken to get it emptied if it were completely filled with kerosene Will be
a) 20√2 minutes b) 30√2 minutes c) 25√2 minutes **d) 10√2 minutes**