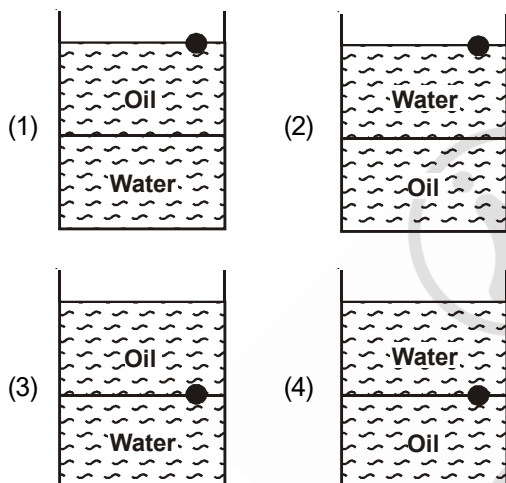


# Chapter 8

## Mechanical Properties of Fluids

1. A ball is made of a material of density  $\rho$  where  $\rho_{\text{oil}} < \rho < \rho_{\text{water}}$  with  $\rho_{\text{oil}}$  and  $\rho_{\text{water}}$  representing the densities of oil and water, respectively. The oil and water are immiscible. If the above ball is in equilibrium in a mixture of this oil and water, which of the following pictures represents its equilibrium positions? [AIEEE-2010]



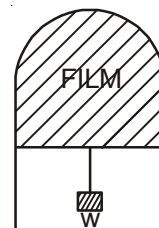
2. Two mercury drops (each of radius  $r$ ) merge to form a bigger drop. The surface energy of the bigger drop, if  $T$  is the surface tension, is [AIEEE-2011]

- (1)  $2^{8/3}\pi r^2 T$  (2)  $2^{5/3}\pi r^2 T$   
(3)  $4\pi r^2 T$  (4)  $2\pi r^2 T$

3. If a ball of steel (density  $\rho = 7.8 \text{ g cm}^{-3}$ ) attains a terminal velocity of  $10 \text{ cm s}^{-1}$  when falling in a tank of water (coefficient of viscosity  $\eta_{\text{water}} = 8.5 \times 10^{-4} \text{ Pa s}$ ), then its terminal velocity in glycerine ( $\rho = 1.2 \text{ g cm}^{-3}$ ,  $\eta = 13.2 \text{ Pa. s}$ ) would be, nearly [AIEEE-2011]

- (1)  $1.5 \times 10^{-5} \text{ cm s}^{-1}$  (2)  $1.6 \times 10^{-5} \text{ cm s}^{-1}$   
(3)  $6.25 \times 10^{-4} \text{ cm s}^{-1}$  (4)  $6.45 \times 10^{-4} \text{ cm s}^{-1}$

4. A thin liquid film formed between a U-shaped wire and a light slider supports a weight of  $1.5 \times 10^{-2} \text{ N}$  (see figure). The length of the slider is 30 cm and its weight negligible. The surface tension of the liquid film is [AIEEE-2012]



- (1)  $0.1 \text{ Nm}^{-1}$  (2)  $0.05 \text{ Nm}^{-1}$   
(3)  $0.025 \text{ Nm}^{-1}$  (4)  $0.0125 \text{ Nm}^{-1}$

5. A uniform cylinder of length  $L$  and mass  $M$  having cross-sectional area  $A$  is suspended, with its length vertical, from a fixed point by a massless spring, such that it is half submerged in a liquid of density  $\sigma$  at equilibrium position. The extension  $x_0$  of the spring when it is in equilibrium is [JEE (Main)-2013]

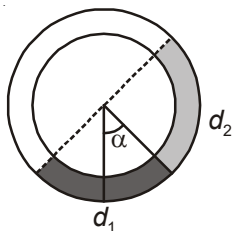
- (1)  $\frac{Mg}{k}$  (2)  $\frac{Mg}{k} \left(1 - \frac{LA\sigma}{M}\right)$   
(3)  $\frac{Mg}{k} \left(1 - \frac{LA\sigma}{2M}\right)$  (4)  $\frac{Mg}{k} \left(1 + \frac{LA\sigma}{M}\right)$

(Here  $k$  is spring constant)

6. 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  $\rho$  and  $L$  is its latent heat of vaporization. [JEE (Main)-2013]

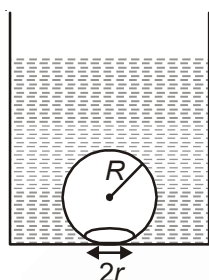
- (1)  $\rho L/T$  (2)  $\sqrt{T/\rho L}$   
(3)  $T/\rho L$  (4)  $2 T/\rho L$

7. There is a circular tube in a vertical plane. Two liquids which do not mix and of densities  $d_1$  and  $d_2$  are filled in the tube. Each liquid subtends  $90^\circ$  angle at centre. Radius joining their interface makes an angle  $\alpha$  with vertical. Ratio  $\frac{d_1}{d_2}$  is [JEE (Main)-2014]



- (1)  $\frac{1 + \sin \alpha}{1 - \sin \alpha}$  (2)  $\frac{1 + \cos \alpha}{1 - \cos \alpha}$   
 (3)  $\frac{1 + \tan \alpha}{1 - \tan \alpha}$  (4)  $\frac{1 + \sin \alpha}{1 - \cos \alpha}$

8. On heating water, bubbles being formed at the bottom of the vessel detach and rise. Take the bubbles to be spheres of radius  $R$  and making a circular contact of radius  $r$  with the bottom of the vessel. If  $r \ll R$ , and the surface tension of water is  $T$ , value of  $r$  just before bubbles detach is (Density of water is  $\rho_w$ ) **[JEE (Main)-2014]**



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

9. The top of a water tank is open to air and its water level is maintained. It is giving out  $0.74 \text{ m}^3$  water per minute through a circular opening of 2 cm radius in its wall. The depth of the centre of the opening from the level of water in the tank is close to **[JEE (Main)-2019]**

- (1) 9.6 m (2) 2.9 m  
 (3) 4.8 m (4) 6.0 m

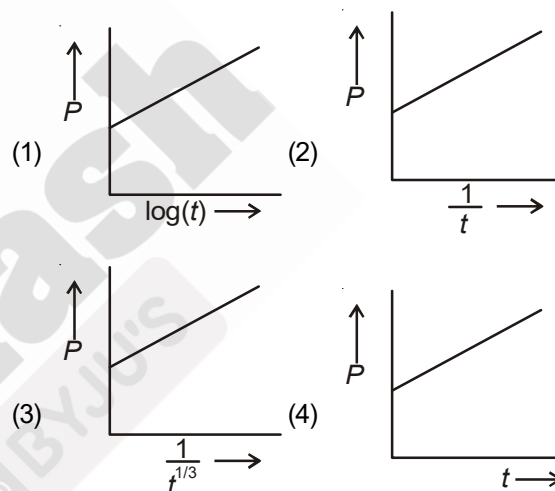
10. Water flows into a large tank with flat bottom at the rate of  $10^{-4} \text{ m}^3 \text{ s}^{-1}$ . Water is also leaking out of a hole of area  $1 \text{ cm}^2$  at its bottom. If the height of the water in the tank remains steady, then this height is **[JEE (Main)-2019]**

- (1) 5.1 cm (2) 1.7 cm  
 (3) 2.9 cm (4) 4 cm

11. A liquid of density  $\rho$  is coming out of a hose pipe of radius  $a$  with horizontal speed  $v$  and hits a mesh. 50% of the liquid passes through the mesh unaffected. 25% loses all of its momentum and 25% comes back with the same speed. The resultant pressure on the mesh will be **[JEE (Main)-2019]**

- (1)  $\frac{3}{4} \rho v^2$  (2)  $\frac{1}{4} \rho v^2$   
 (3)  $\frac{1}{2} \rho v^2$  (4)  $\rho v^2$

12. A soap bubble, blown by a mechanical pump at the mouth of a tube, increases in volume, with time, at a constant rate. The graph that correctly depicts the time dependence of pressure inside the bubble is given by **[JEE (Main)-2019]**



13. A long cylindrical vessel is half filled with a liquid. When the vessel is rotated about its own vertical axis, the liquid rises up near the wall. If the radius of vessel is 5 cm and its rotational speed is 2 rotations per second, then the difference in the heights between the centre and the sides, in cm, will be **[JEE (Main)-2019]**

- (1) 1.2 (2) 0.1  
 (3) 0.4 (4) 2.0

14. Water from a pipe is coming at a rate of 100 liters per minute. If the radius of the pipe is 5 cm, the Reynolds number for the flow is of the order of : (density of water =  $1000 \text{ kg/m}^3$ , coefficient of viscosity of water =  $1 \text{ mPa s}$ ) **[JEE (Main)-2019]**

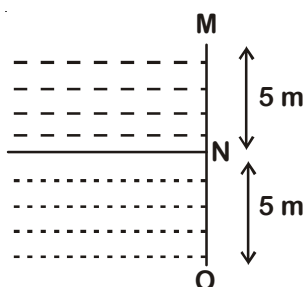
- (1)  $10^2$  (2)  $10^4$   
 (3)  $10^3$  (4)  $10^6$

15. If  $M$  is the mass of water that rises in a capillary tube of radius  $r$ , then mass of water which will rise in a capillary tube of radius  $2r$  is  
[JEE (Main)-2019]  
(1)  $2M$  (2)  $M$   
(3)  $4M$  (4)  $\frac{M}{2}$
16. A wooden block floating in a bucket of water has  $\frac{4}{5}$  of its volume submerged. When certain amount of an oil is poured into the bucket, it is found that the block is just under the oil surface with half of its volume under water and half in oil. The density of oil relative to that of water is [JEE (Main)-2019]  
(1) 0.5 (2) 0.8  
(3) 0.7 (4) 0.6
17. The ratio of surface tensions of mercury and water is given to be 7.5 while the ratio of their densities is 13.6. Their contact angles, with glass, are close to  $135^\circ$  and  $0^\circ$ , respectively. It is observed that mercury gets depressed by an amount  $h$  in a capillary tube of radius  $r_1$ , while water rises by the same amount  $h$  in a capillary tube of radius  $r_2$ . The ratio,  $(r_1/r_2)$ , is then close to : [JEE (Main)-2019]  
(1)  $4/5$  (2)  $2/3$   
(3)  $3/5$  (4)  $2/5$
18. A cubical block of side 0.5 m floats on water with 30% of its volume under water. What is the maximum weight that can be put on the block without fully submerging it under water?  
[Take, density of water =  $10^3 \text{ kg/m}^3$ ]  
[JEE (Main)-2019]  
(1) 30.1 kg (2) 46.3 kg  
(3) 87.5 kg (4) 65.4 kg
19. Water from a tap emerges vertically downwards with an initial speed of  $1.0 \text{ ms}^{-1}$ . The cross-sectional area of the tap is  $10^{-4} \text{ m}^2$ . Assume that the pressure is constant throughout the stream of water and that the flow is streamlined. The cross-sectional area of stream, 0.15 m below the tap would be:  
(Take  $g = 10 \text{ ms}^{-2}$ ) [JEE (Main)-2019]  
(1)  $1 \times 10^{-5} \text{ m}^2$   
(2)  $5 \times 10^{-5} \text{ m}^2$   
(3)  $5 \times 10^{-4} \text{ m}^2$   
(4)  $2 \times 10^{-5} \text{ m}^2$
20. A submarine experiences a pressure of  $5.05 \times 10^6 \text{ Pa}$  at a depth of  $d_1$  in a sea. When it goes further to a depth of  $d_2$ , it experiences a pressure of  $8.08 \times 10^6 \text{ Pa}$ . Then  $d_2 - d_1$  is approximately (density of water =  $10^3 \text{ kg/m}^3$  and acceleration due to gravity =  $10 \text{ ms}^{-2}$ ) :  
[JEE (Main)-2019]  
(1) 600 m  
(2) 500 m  
(3) 300 m  
(4) 400 m
21. A solid sphere, of radius  $R$  acquires a terminal velocity  $v_1$  when falling (due to gravity) through a viscous fluid having a coefficient of viscosity  $\eta$ . The sphere is broken into 27 identical solid spheres. If each of these spheres acquires a terminal velocity,  $v_2$ , when falling through the same fluid, the ratio  $\left(\frac{v_1}{v_2}\right)$  equals [JEE (Main)-2019]  
(1)  $\frac{1}{27}$  (2) 9  
(3)  $\frac{1}{9}$  (4) 27
22. An ideal fluid flows (laminar flow) through a pipe of non-uniform diameter. The maximum and minimum diameters of the pipes are 6.4 cm and 4.8 cm, respectively. The ratio of the minimum and the maximum velocities of fluid in this pipe is [JEE (Main)-2020]  
(1)  $\frac{81}{256}$  (2)  $\frac{9}{16}$   
(3)  $\frac{3}{4}$  (4)  $\frac{\sqrt{3}}{2}$
23. Consider a solid sphere of radius  $R$  and mass density  $\rho(r) = \rho_0 \left(1 - \frac{r^2}{R^2}\right)$ ,  $0 < r \leq R$ . The minimum density of a liquid in which it will float is [JEE (Main)-2020]  
(1)  $\frac{2\rho_0}{5}$  (2)  $\frac{\rho_0}{3}$   
(3)  $\frac{\rho_0}{5}$  (4)  $\frac{2\rho_0}{3}$

24. A leak proof cylinder of length 1 m, made of a metal which has very low coefficient of expansion is floating vertically in water at  $0^\circ\text{C}$  such that its height above the water surface is 20 cm. When the temperature of water is increased to  $4^\circ\text{C}$ , the height of the cylinder above the water surface becomes 21 cm. The density of water at  $T = 4^\circ\text{C}$ , relative to the density at  $T = 0^\circ\text{C}$  is close to [JEE (Main)-2020]

- (1) 1.04  
(2) 1.03  
(3) 1.26  
(4) 1.01

25.

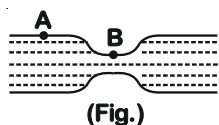


Two liquids of densities  $\rho_1$  and  $\rho_2$  ( $\rho_2 = 2\rho_1$ ) are filled up behind a square wall of side 10 m as shown in figure. Each liquid has a height of 5 m. The ratio of the forces due to these liquids exerted on upper part  $MN$  to that at the lower part  $NO$  is (Assume that the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

[JEE (Main)-2020]

- (1)  $1/4$   
(2)  $1/2$   
(3)  $2/3$   
(4)  $1/3$

26. Water flows in a horizontal tube (see figure). The pressure of water changes by  $700 \text{ Nm}^{-2}$  between  $A$  and  $B$  where the area of cross section are  $40 \text{ cm}^2$  and  $20 \text{ cm}^2$ , respectively. Find the rate of flow of water through the tube. [JEE (Main)-2020]  
(density of water =  $1000 \text{ kg m}^{-3}$ )

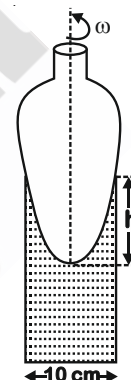


- (1)  $3020 \text{ cm}^3/\text{s}$  (2)  $1810 \text{ cm}^3/\text{s}$   
(3)  $2720 \text{ cm}^3/\text{s}$  (4)  $2420 \text{ cm}^3/\text{s}$

27. A small spherical droplet of density  $d$  is floating exactly half immersed in a liquid of density  $\rho$  and surface tension  $T$ . The radius of the droplet is (take note that the surface tension applies an upward force on the droplet) [JEE (Main)-2020]

(1)  $r = \sqrt{\frac{3T}{(2d - \rho)g}}$  (2)  $r = \sqrt{\frac{T}{(d + \rho)g}}$   
(3)  $r = \sqrt{\frac{T}{(d - \rho)g}}$  (4)  $r = \sqrt{\frac{2T}{3(d + \rho)g}}$

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



(1)  $\frac{2\omega^2}{25g}$  (2)  $\frac{5\omega^2}{2g}$   
(3)  $\frac{2\omega^2}{5g}$  (4)  $\frac{25\omega^2}{2g}$

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

- (1) 0.049 m  
(2) 0.087 m  
(3) 0.137 m  
(4) 0.172 m

30. Pressure inside two soap bubbles are 1.01 and 1.02 atmosphere, respectively. The ratio of their volumes is  
[JEE (Main)-2020]  
(1) 2 : 1 (2) 0.8 : 1  
(3) 4 : 1 (4) 8 : 1
31. A air bubble of radius 1 cm in water has an upward acceleration  $9.8 \text{ cm s}^{-2}$ . The density of water is  $1 \text{ gm cm}^{-3}$  and water offers negligible drag force on the bubble. The mass of the bubble is ( $g = 980 \text{ cm/s}^2$ )  
[JEE (Main)-2020]  
(1) 1.52 gm (2) 4.51 gm  
(3) 3.15 gm (4) 4.15 gm
32. Two identical cylindrical vessels are kept on the ground and each contain the same liquid of density  $d$ . The area of the base of both vessels is  $S$  but the height of liquid in one vessel is  $x_1$  and in the other,  $x_2$ . When both cylinders are connected through a pipe of negligible volume very close to the bottom, the liquid flows from one vessel to the other until it comes to equilibrium at a new height. The change in energy of the system in the process is  
[JEE (Main)-2020]  
(1)  $gdS(x_2 + x_1)^2$  (2)  $\frac{1}{4}gdS(x_2 - x_1)^2$   
(3)  $\frac{3}{4}gdS(x_2 - x_1)^2$  (4)  $gdS(x_2^2 + x_1^2)$
33. A hollow spherical shell at outer radius  $R$  floats just submerged under the water surface. The inner radius of the shell is  $r$ . If the specific gravity of the shell material is  $\frac{27}{8}$  w.r.t water, the value of  $r$  is  
[JEE (Main)-2020]  
(1)  $\frac{2}{3}R$  (2)  $\frac{4}{9}R$   
(3)  $\frac{1}{3}R$  (4)  $\frac{8}{9}R$
34. In an experiment to verify Stokes law, a small spherical ball of radius  $r$  and density  $\rho$  falls under gravity through a distance  $h$  in air before entering a tank of water. If the terminal velocity of the ball inside water is same as its velocity just before entering the water surface, then the value of  $h$  is proportional to  
[JEE (Main)-2020]  
(ignore viscosity of air)  
(1)  $r^4$  (2)  $r^3$   
(3)  $r$  (4)  $r^2$
35. A fluid is flowing through a horizontal pipe of varying cross-section, with speed  $v \text{ ms}^{-1}$  at a point where the pressure is  $P$  pascal.  
At another point where pressure is  $\frac{P}{2}$  pascal its speed is  $V \text{ ms}^{-1}$ . If the density of the fluid is  $\rho \text{ kg m}^{-3}$  and the flow is streamline, then  $V$  is equal to  
[JEE (Main)-2020]  
(1)  $\sqrt{\frac{P}{\rho} + v^2}$  (2)  $\sqrt{\frac{2P}{\rho} + v^2}$   
(3)  $\sqrt{\frac{P}{\rho} + v}$  (4)  $\sqrt{\frac{P}{2\rho} + v^2}$
36. When a long glass capillary tube of radius 0.015 cm is dipped in a liquid, the liquid rises to a height of 15 cm within it. If the contact angle between the liquid and glass is close to  $0^\circ$ , the surface tension of the liquid, in milliNewton  $\text{m}^{-1}$ , is [ $\rho_{\text{(liquid)}} = 900 \text{ kgm}^{-3}$ ,  $g = 10 \text{ ms}^{-2}$ ] (Give answer in closest integer)  
[JEE (Main)-2020]
37. A hydraulic press can lift 100 kg when a mass 'm' is placed on the smaller piston. It can lift \_\_\_\_\_ kg when the diameter of the larger piston is increased by 4 times and that of the smaller piston is decreased by 4 times keeping the same mass 'm' on the smaller piston.  
[JEE (Main)-2021]
38. A large number of water drops, each of radius  $r$ , combine to have a drop of radius  $R$ . If the surface tension is  $T$  and mechanical equivalent of heat is  $J$ , the rise in heat energy per unit volume will be  
[JEE (Main)-2021]  
(1)  $\frac{2T}{J} \left( \frac{1}{r} - \frac{1}{R} \right)$  (2)  $\frac{3T}{rJ}$   
(3)  $\frac{3T}{J} \left( \frac{1}{r} - \frac{1}{R} \right)$  (4)  $\frac{2T}{rJ}$
39. The pressure acting on a submarine is  $3 \times 10^5 \text{ Pa}$  at a certain depth. If the depth is doubled, the percentage increase in the pressure acting on the submarine would be:  
[JEE (Main)-2021]  
(Assume that atmospheric pressure is  $1 \times 10^5 \text{ Pa}$ , density of water is  $10^3 \text{ kg m}^{-3}$ ,  $g = 10 \text{ ms}^{-2}$ )  
(1)  $\frac{200}{5} \%$  (2)  $\frac{3}{200} \%$   
(3)  $\frac{200}{3} \%$  (4)  $\frac{5}{200} \%$



40. What will be the nature of flow of water from a circular tap, when its flow rate increased from 0.18 L/min to 0.48 L/min? The radius of the tap and viscosity of water are 0.5 cm and  $10^{-3}$  Pa s, respectively. **[JEE (Main)-2021]**

(Density of water :  $10^3$  kg/m<sup>3</sup>)

- (1) Steady flow to unsteady flow  
(2) Remains turbulent flow  
(3) Unsteady to steady flow  
(4) Remains steady flow
41. When two soap bubbles of radii  $a$  and  $b$  ( $b > a$ ) coalesce, the radius of curvature of common surface is **[JEE (Main)-2021]**

(1)  $\frac{ab}{b-a}$  (2)  $\frac{ab}{a+b}$

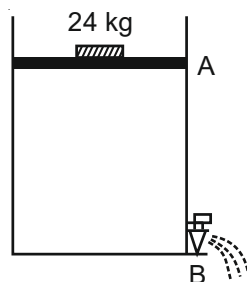
(3)  $\frac{b-a}{ab}$  (4)  $\frac{a+b}{ab}$

42. Consider a water tank as shown in the figure. Its cross-sectional area is 0.4 m<sup>2</sup>. The tank has an opening B near the bottom whose cross-section area is 1 cm<sup>2</sup>. A load of 24 kg is applied on the water at the top when the height of the water level is 40 cm above the bottom, the velocity of water coming out the opening B is  $v$  ms<sup>-1</sup>.

The value of  $v$ , to the nearest integer, is \_\_\_\_\_.

[Take value of  $g$  to be 10 ms<sup>-2</sup>]

**[JEE (Main)-2021]**



43. Two small drops of mercury each of radius  $R$  coalesce to form a single large drop. The ratio of total surface energy before and after the change is

**[JEE (Main)-2021]**

(1) 2 : 1 (2) 1 : 2

(3)  $2^{\frac{1}{3}}$  : 1 (4) 1 :  $2^{\frac{1}{3}}$

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

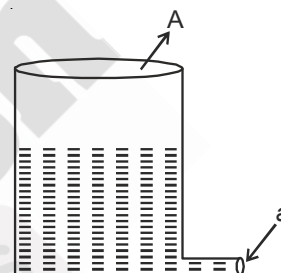
**[JEE (Main)-2021]**

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

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

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

**[JEE (Main)-2021]**



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

(3)  $\frac{2a}{A}$  (4)  $\frac{a}{A}$

46. A raindrop with radius  $R = 0.2$  mm falls from a cloud at a height  $h = 2000$  m above the ground. Assume that the drop is spherical throughout its fall and the force of buoyance may be neglected, then the terminal speed attained by the raindrop is

[Density of water  $\rho_w = 1000$  kg m<sup>-3</sup> and

Density of air  $\rho_a = 1.2$  kg m<sup>-3</sup>,  $g = 10$  m/s<sup>2</sup>

Coefficient of viscosity of air =  $1.8 \times 10^{-5}$  Nsm<sup>-2</sup>]

**[JEE (Main)-2021]**

(1) 250.6 ms<sup>-1</sup>

(2) 14.4 ms<sup>-1</sup>

(3) 43.56 ms<sup>-1</sup>

(4) 4.94 ms<sup>-1</sup>

47. The water is filled upto height of 12 m in a tank having vertical sidewalls. A hole is made in one of the walls at a depth 'h' below the water level. The value of 'h' for which the emerging stream of water strikes the ground at the maximum range is \_\_\_\_ m. [JEE (Main)-2021]

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

[Take surface tension of water  $T = 7.3 \times 10^{-2} \text{ Nm}^{-1}$ , angle of contact = 0,  $g = 10 \text{ ms}^{-2}$  and density of water =  $1.0 \times 10^3 \text{ kg m}^{-3}$ ] [JEE (Main)-2021]

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

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

50. In Millikan's oil drop experiment, what is viscous force acting on an uncharged drop of radius  $2.0 \times 10^{-5} \text{ m}$  and density  $1.2 \times 10^3 \text{ kgm}^{-3}$ ? Take viscosity of liquid =  $1.8 \times 10^{-5} \text{ Nsm}^{-2}$ . (Neglect buoyancy due to air). [JEE (Main)-2021]

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

51. When a rubber ball is taken to a depth of \_\_\_\_ m in deep sea, its volume decreases by 0.5%.

(The bulk modulus of rubber =  $9.8 \times 10^8 \text{ Nm}^{-2}$ ,

Density of sea water =  $10^3 \text{ kgm}^{-3}$ ,  $g = 9.8 \text{ m/s}^2$ )

[JEE (Main)-2021]

52. The terminal velocity ( $v_t$ ) of the spherical rain drop depends on the radius ( $r$ ) of the spherical rain drop as

[JEE (Main)-2022]

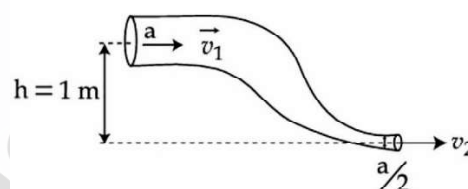
- (1)  $r^{1/2}$  (2)  $r$   
(3)  $r^2$  (4)  $r^3$

53. The velocity of upper layer of water in a river is  $36 \text{ kmh}^{-1}$ . Shearing stress between horizontal layers of water is  $10^{-3} \text{ Nm}^{-2}$ . Depth of the river is \_\_\_\_ m. (Co-efficient of viscosity of water is  $10^{-2} \text{ Pa.s}$ )

[JEE (Main)-2022]

54. An ideal fluid of density  $800 \text{ kg m}^{-3}$ , flows smoothly through a bent pipe (as shown in figure) that tapers in cross-sectional area from  $a$  to  $\frac{a}{2}$ . The pressure difference between the wide and narrow sections of pipe is  $4100 \text{ Pa}$ . At wider section, the velocity of fluid is  $\frac{\sqrt{x}}{6} \text{ ms}^{-1}$  for  $x = \underline{\hspace{2cm}}$ . (Given  $g = 10 \text{ ms}^{-2}$ )

[JEE (Main)-2022]



55. The velocity of a small ball of mass 'm' and density  $d_1$ , when dropped in a container filled with glycerine, becomes constant after some time. If the density of glycerine is  $d_2$ , then the viscous force acting on the ball, will be [JEE (Main)-2022]

- (1)  $mg \left(1 - \frac{d_1}{d_2}\right)$  (2)  $mg \left(1 - \frac{d_2}{d_1}\right)$   
(3)  $mg \left(\frac{d_1}{d_2} - 1\right)$  (4)  $mg \left(\frac{d_2}{d_1} - 1\right)$

56. The area of cross-section of a large tank is  $0.5 \text{ m}^2$ . It has a narrow opening near the bottom having area of cross-section  $1 \text{ cm}^2$ . A load of  $25 \text{ kg}$  is applied on the water at the top in the tank. Neglecting the speed of water in the tank, the velocity of the water, coming out of the opening at the time when the height of water level in the tank is  $40 \text{ cm}$  above the bottom, will be \_\_\_\_  $\text{cms}^{-1}$ .

[Take  $g = 10 \text{ ms}^{-2}$ ]

[JEE (Main)-2022]

57. A water drop of diameter 2 cm is broken into 64 equal droplets. The surface tension of water is 0.075 N/m. In this process the gain in surface energy will be

[JEE (Main)-2022]

- (1)  $2.8 \times 10^{-4}$  J                      (2)  $1.5 \times 10^{-3}$  J  
(3)  $1.9 \times 10^{-4}$  J                      (4)  $9.4 \times 10^{-5}$  J

58. A water drop of radius 1 mm falls in a situation where the effect of buoyant force is negligible. Co-efficient of viscosity of air is  $1.8 \times 10^{-5}$  Nsm<sup>-2</sup> and its density is negligible as compared to that of water ( $10^6$  gm<sup>-3</sup>). Terminal velocity of the water drop is (Take acceleration due to gravity = 10 ms<sup>-2</sup>)

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- (1)  $145.4 \times 10^{-6}$  ms<sup>-1</sup>  
(2)  $118.0 \times 10^{-6}$  ms<sup>-1</sup>  
(3)  $132.6 \times 10^{-6}$  ms<sup>-1</sup>  
(4)  $123.4 \times 10^{-6}$  ms<sup>-1</sup>

59. A liquid of density 750 kgm<sup>-3</sup> flows smoothly through a horizontal pipe that tapers in cross-sectional area from  $A_1 = 1.2 \times 10^{-2}$  m<sup>2</sup> to  $A_2 = \frac{A_1}{2}$ . The pressure difference between the wide and narrow sections of the pipe is 4500 Pa. The rate of flow of liquid is \_\_\_\_\_  $\times 10^{-3}$  m<sup>3</sup>s<sup>-1</sup>.

[JEE (Main)-2022]

60. A small spherical ball of radius 0.1 mm and density  $10^4$  kg m<sup>-3</sup> falls freely under gravity through a distance  $h$  before entering a tank of water. If, after entering the water the velocity of ball does not change and it continues to fall with same constant velocity inside water, then the value of  $h$  will be \_\_\_\_\_ m.

(Given  $g = 10$  ms<sup>-2</sup>, viscosity of water =  $1.0 \times 10^{-5}$  N-sm<sup>-2</sup>).

[JEE (Main)-2022]

61. A drop of liquid of density  $\rho$  is floating half immersed in a liquid of density  $\sigma$  and surface tension  $7.5 \times 10^{-4}$  N cm<sup>-1</sup>. The radius of drop in cm will be ( $g = 10$  ms<sup>-2</sup>)

[JEE (Main)-2022]

- (1)  $\frac{15}{\sqrt{(2\rho - \sigma)}}$                       (2)  $\frac{15}{\sqrt{(\rho - \sigma)}}$   
(3)  $\frac{3}{2\sqrt{(\rho - \sigma)}}$                       (4)  $\frac{3}{20\sqrt{(2\rho - \sigma)}}$

62. A water drop of radius 1 cm is broken into 729 equal droplets. If surface tension of water is 75 dyne/cm, then the gain in surface energy upto first decimal place will be :

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(Given  $\pi = 3.14$ )

- (1)  $8.5 \times 10^{-4}$  J                      (2)  $8.2 \times 10^{-4}$  J  
(3)  $7.5 \times 10^{-4}$  J                      (4)  $5.3 \times 10^{-4}$  J

63. A spherical soap bubble of radius 3 cm is formed inside another spherical soap bubble of radius 6 cm. If the internal pressure of the smaller bubble of radius 3 cm in the above system is equal to the internal pressure of the another single soap bubble of radius  $r$  cm. The value of  $r$  is \_\_\_\_\_

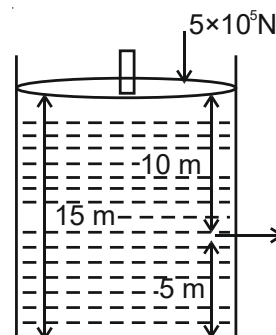
[JEE (Main)-2022]

64. The diameter of an air bubble which was initially 2 mm, rises steadily through a solution of density 1750 kg m<sup>-3</sup> at the rate of 0.35 cms<sup>-1</sup>. The coefficient of viscosity of the solution is \_\_\_\_\_ poise (in nearest integer). (The density of air is negligible).

[JEE (Main)-2022]

65. Consider a cylindrical tank of radius 1 m is filled with water. The top surface of water is at 15 m from the bottom of the cylinder. There is a hole on the wall of cylinder at a height of 5 m from the bottom. A force of  $5 \times 10^5$  N is applied on the top surface of water using a piston. The speed of efflux from the hole will be: (given atmosphere pressure  $P_A = 1.01 \times 10^5$  Pa, density of water  $\rho_w = 1000$  kg/m<sup>3</sup> and gravitational acceleration  $g = 10$  m/s<sup>2</sup>)

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- (1) 11.6 m/s                      (2) 10.8 m/s  
(3) 17.8 m/s                      (4) 14.4 m/s



66. Given below are two statements: One is labelled as **Assertion (A)** and the other is labelled as **Reason (R)**.  
[JEE (Main)-2022]

**Assertion (A)** : Clothes containing oil or grease stains cannot be cleaned by water wash.

**Reason (R)** : Because the angle of contact between the oil/ grease and water is obtuse.

In the light of the above statements, choose the correct answer from the option given below.

- (1) Both **(A)** and **(R)** are true and **(R)** is the correct explanation of **(A)**
- (2) Both **(A)** and **(R)** are true but **(R)** is not the correct explanation of **(A)**
- (3) **(A)** is true but **(R)** is false
- (4) **(A)** is false but **(R)** is true

67. The velocity of a small ball of mass 0.3 g and density 8 g/cc when dropped in a container filled with glycerine becomes constant after some time. If the density of glycerine is 1.3 g/cc, then the value of viscous force acting on the ball will be  $x \times 10^{-4}$  N. The value of  $x$  is \_\_\_\_\_. [use  $g = 10 \text{ m/s}^2$ ]

[JEE (Main)-2022]

68. A tube of length 50 cm is filled completely with an incompressible liquid of mass 250 g and closed at both ends. The tube is then rotated in horizontal plane about one of its ends with a uniform angular velocity  $x\sqrt{F}$   $\text{rads}^{-1}$ . If  $F$  be the force exerted by the liquid at the other end then the value of  $x$  will be \_\_\_\_\_

[JEE (Main)-2022]

69. If  $\rho$  is the density and  $\eta$  is coefficient of viscosity of fluid which flows with a speed  $v$  in the pipe of diameter  $d$ , the correct formula for Reynolds number  $R_e$  is:

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

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

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

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

