PHYSICS

BOOKS - DISHA PUBLICATION PHYSICS (HINGLISH)

MECHANICAL PROPERTIES OF FLUIDS

Jee Main 5 Years At A Glance

1. A small soap bubble of radius 4 cm is trapped inside another bubble of radius 6 cm without any contact. Let P_2 be the pressure inside the inner bubble and P_0, the pressure outside the outer bubble. Radius of another bubble with pressure difference $P_2 - P_0$ between its inside and outside would be :

A. 6 cm

B. 12 cm

C. $4.8cm$

D. $2.\ 4cm$

Answer: D

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2. When an air bubble of radius $'r'$ rises from the bottom to the surface of a lake, its radius becomes $5r/4$ (the pressure of the atmosphere is equal to the $10m$ height of water column). If the temperature is constant and the surface tension is neglected, the depth of the lake is

A. $10.5m$

B. $8.7m$

C. $11.2m$

D. $9.5m$

Answer: D

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3. Two tubes of radii r_1 and r_2 and lengths l_1 and l_2 respectively, are connected in series and a liquid flows through each of them in streamline conditions. P_1 and P_2 are pressure differences across the two tubes. IfP_2 is$4P_1$ and l_2 is $\frac{l_1}{4}$ then the radius r, will be equal to:

A. r_1

B. $2r_1$

C. $4r_1$

D. $\frac{r_1}{2}$

Answer: D

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4. Which of the following option correctly describes the variation of the speed and acceleration $'a'$ of a point mass falling vertically in a viscous medium that applies a force $F = -kv$, where $'k'$ is constant, on the body?

(Graphs are schematic and drawn to scale)

A.

B.

C.

D.

Answer: C

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5. If it takes 5 minutes to fill a 15 litre bucket from a water tap diameter $\frac{2}{\sqrt{\pi}}$ cm then the raynolds number for the flow is (density of water $= 10^3 kg / m^3$ and viscosity of water $= 10^{-3} Pa.s$) close to

A. 100

B. 11000

C. 550

D. 5500

Answer: D

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6. The velocity of water in a rier is $18kmh^{-1}$ near the surface. If the river is 5 m deepm, find the shearing stress between the horizontal lyers of water. The coefficient of viscosity of water `=10^-2

poise.

A. $10^{-1}N/m^2$

B. $10^{-2}N/m^2$

C. $10^{-3}N/m^2$

D. $10^{-4}N/m^2$

Answer: B

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7. An open glass tube is immersed in mercury in such a way that a length of 8 cm extends above the mercury level. The open end of the tube is then closed and sealed and the tube is raised vertically up by additional 46 cm. what will be length of the air column above mercury in the above now ?

(Atmospheric pressure = 76 cm of Hg)

A. 16cm

B. 22cm

C. 38cm

D. 6cm

Answer: A

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Exercise 1 Concept Builder

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

A. acceleration due to gravity

B. height of the liquid column

C. area of the bottom surface

D. nature of the liquid A beaker containing a liquid of density p moves up with an acceleration

Answer: C

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2. How does liquid pressure depend on the depth of a point below the surface of a liquid

A. $h\rho g$

B. $h\rho(g-a)$

C. $h\rho(g+a)$

D. $2h\rho g\left(\frac{g+a}{g-a}\right)$

Answer: C

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3. An egg when placed in ordinary water sinks but floats when placed in brine. This is because

A. density of brine is less than that of ordinary water

B. density of brine is equal to that of ordinary water

C. density of brine is greater than that of ordinary water

D. None of these

Answer: C

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4. A common hydrometer reads specific gravity of liquids Compared to the 1.6 mark of the stem the mark 1.5 will be

A. upwards

B. downwards

C. in the same place

D. may be upward or downward depending upon the hydrometer

Answer: A

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5. The spring balance A reads 2 kg with a block of mass m suspended from it. A balance B reads 5 kg when a beaker with liquid is put on the pan of the balance. The two balances are now so arranged that the hanging mass is inside the liquid in a beaker as shown in fig. Then

A. balance A will read more than 2 kg

B. balance B will read less than 5 kg

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

D. balance A will read more than 2 kg and B will read less than 5 kg

Answer: C

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6. The density of ice is $x gm / cc$ and that of water is $y gm / cc$. What is the change in volume in cc, when $m gm$ of ice metls?

A. $my(x - y)$

B. $m / (y - x)$

C. $m\left(\frac{1}{y}-\frac{1}{y}\right)$

D. $(y-x)/x$

Answer: C

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7. A small lead shot is embedded in a big lump of ice floating in a jar of water. The level of water in the jar is noted. When all the ice melts down, the level of water in the jar would

A. be raised

B. go down

C. remain unchanged

D. None of these

Answer: B

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8. The pressure at depth h below the surface of a liquid of density ρ open to the atmosphere is

A. greater than the atmospheric pressure by pgh

B. less than the atmospheric pressure by pgh

C. equal to the atmospheric pressure

D. decreases exponentially with depth

Answer: A

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9. The force acting on a window of are 50 $\times$ 50 cm of a submarine at a depth of 2000 m in an ocean ,the interior of which is maintained at sea level atmospheric pressure is (density of sea water = $10^3 kgm^{-3}$,g =$10 ms^{-2}$)

A. $10^6 N$

B. $5 \times 10^5 N$

C. $25 \times N 10^6 N$

D. $5 \times 10^6 N$

Answer: D

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10. A wooden block, with a coin placed on its top, floats in water as shown in fig. the distance 1 and h are shown there. After some time the coin falls into the water. Then

A. l decreases and h increasesCoin

B. l increases and h decreases

C. both C and h increases

D. both and h decreases

Answer: D

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11. The density ρ of water of buk modulus B at a depth y then ocean is related to the density at surface ρ_0 by the relation

A. $\rho = \rho_0 \left[1 - \frac{\rho_0 g y}{B}\right]$

B. $\rho = \rho_0 \left[1 + \frac{\rho_0 g y}{B}\right]$

C. $\rho = \rho_0 \left[1 + \frac{B}{\rho_0 h g y}\right]$

D. $\rho = \rho_0 \left[1 - \frac{B}{\rho_0 g y}\right]$

Answer: B

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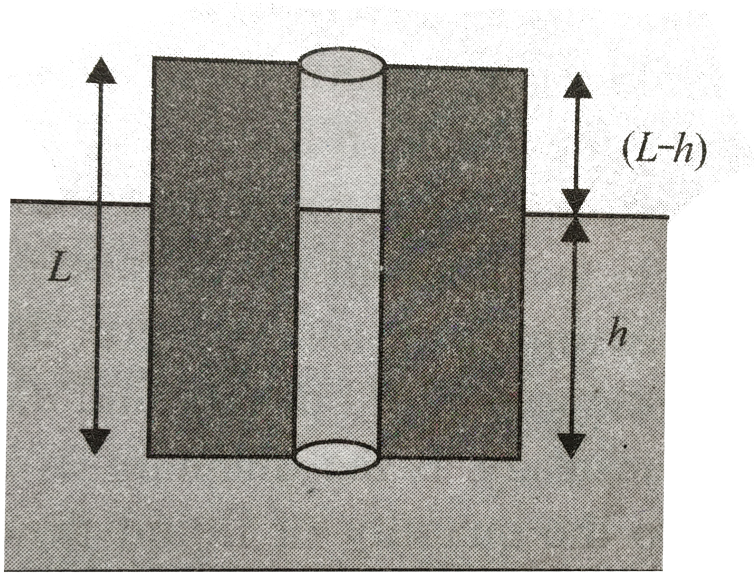
12. A large block of ice $5m$ thick has a vertical hole drilled through it and is floating in the middle of a lake. What is the minimum length of a rope required to scoop up a bucket full of water through the hole? Relative density of ice $= 0.9$.



A. $5.5m$

B. 5m

C. $4.5m$

D. $0.5m$

Answer: D

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13. A sphere of solid material of specific gravity 8 has a concentric spherical cavity and just sinks in water. The ratio of radius of cavity to that of outer radius of the sphere must be

A. $\frac{7^{1/3}}{2}$

B. $\frac{5^{1/3}}{2}$

C. $\frac{9^{1/3}}{2}$

D. $\frac{3^{1/3}}{2}$

Answer: A

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14. A metallic sphere weighs $210g$ in air, 180 g in water and 120 g in an unknown liquid. Find the density of metal and of liquid.

A. the density of the metal is 3 g/cm^3

B. the density of the metal is 7 g/cm^3

C. density of the metal is 4 times the density of unknown liquid

D. the metal still float in water

Answer: A

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15. An iceberg is floating partly immersed in sea water, the density of sea water is $1.03 gcm^{-3}$ and that of ice is $0.92 gcm^{-3}$. The fraction of the total volume of the iceberg above the level of sea water is

A. 8.1%

B. 11%

C. 34%

D. 0.8%

Answer: B

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16. A boat having a length of 3 m and breadth of 2 m is floating on a lake. The boat sinks by 1 cm when a man gets on it. The mass of the mas is:

A. 60 kg

B. 62 kg

C. 72 kg

D. 128 kg

Answer: A

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17. A body of density ρ is dropped from reat from a height h into a lake of density $\sigma(\sigma > \rho)$. The maximum depth the body sinks inside the liquid is (neglect viscous effect of liquid)

A. $\dfrac{h}{\rho - \rho'}$

B. $\dfrac{h\rho'}{\rho}$

C. $\dfrac{h\rho}{\rho - \rho'}$

D. $\dfrac{h\rho'}{\rho}$

Answer: C

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18. A vessel contains oil (density $= 0.8gm / cm^3$) over mercury (density $= 13.6gmcm^3$). A homogeneous sphere floats with half its volume immersed in mercury and the other half in oil. The density of the material of the sphere in gm / cm^3 is

A. 3.3

B. 6.4

C. 7.2

D. 12.8

Answer: C

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19. A sphere of solid material of relative density 9 has a concentric spherical cavity and sinks in water. If the radius of the sphere be R. Then the radius of the cavity (r) will be related to R as

A. $r^3 = \frac{9}{9}R^3$

B. $r^3 = \frac{2}{3}R^3$

C. $r^2 = \frac{\sqrt{8}}{9}R^3$

D. $r^3 = \sqrt{\frac{2}{3}}R^3$

Answer: A

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20. A pieceo of ice is floating in water . Find the fraction of volume of he piece of ice outside the water

(Given density of ice $= 900 kg/m^3$ and density of water $= 1000 kg/m^3$)

A. $\frac{90}{103}$

B. $\frac{13}{103}$

C. $\frac{10}{103}$

D. $\frac{1}{103}$

Answer: B

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21. In car lift compressed air exerts a force F_1 on a small piston having a radius of 5 cm. This pressure is transmitted to a second piston of radius 15 cm. If the mass of the car to be lifted is 1350 kg, what is F_1? What is the pressure necessary to ac complish this task ?

A. $1.4 \times 10^5 Pa$

B. $2 \times 10^5 Pa$

C. $1.9 \times 10^5 Pa$

D. $1.9Pa$

Answer: C

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22. A cone full of water, is placed on its side on a horizontal table, the thrust on its base is x times the weight of the contained fluid, where 2α is the vertical angle of the cone. Find the value of x.

A. $3\cos\alpha$

B. $3\sin\alpha$

C. $2 \sin \alpha$

D. $2 \cos \alpha$

Answer: B

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23. A narrow tube completely filled with a liquid is lying on a series of cylinders as shown in figure. Assuming no sliding between any surfaces, the value of acceleration of the cylinders for which liquid will not come out of the tube from anywhere is given by

A. $\frac{gH}{2L}$

B. $\frac{gH}{L}$

C. $\frac{2gH}{L}$

D. $\frac{gH}{\sqrt{2}L}$

Answer: A

24. The total weight of a piece of wood is 6 kg in the floating state in water its 1/3 part remains inside the water on this floating solid what maximum weight is to be put such that the whole of the piece of wood is to be drowned in the water

A. 15 kg

B. 14 kg

C. 10 kg

D. 12 kg

Answer: D

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25. Water is flowing continuously from a tap having an internal diameter 8×10^{-3}m. The water velocity as it leves the tap is $0.4 ms^{-1}$. The diameter of the water stream at a distance 2×10^{-1}m below the tap is close to $(g = 10 m / s^2)$

A. $7.5 \times 10^{-3} m$

B. $9.6 x 10^{-3} m$

C. $3.6 \times 10^{-3} m$

D. $5.0 \times 10^{-3} m$

Answer: C

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26. The cylinderical tube of a spray pump has radius R, One end of which has n fine holes, each of radius r. If the speed of the liquid in the tube is V, the speed of the ejection of the liquid through the holes is :

A. $\frac{VR^2}{nr^2}$

B. $\frac{VR^2}{n^3r^2}$

C. $\frac{V^2R}{nr}$

D. $\frac{VR^2}{n^2r^2}$

Answer: A

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27. 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 minimum at the narrowest part of thepipe and the pressure is minimum at the widest part of the pipe

B. The veloeity is maximum at the narrowest part of the pipe and pressure is maximum at the widest part of the pipe

C. Velocity and pressure both are maximum at the narrowest part of the pipe

D. Velocity and pressure both are maximum at the widest part of the pipe

Answer: B

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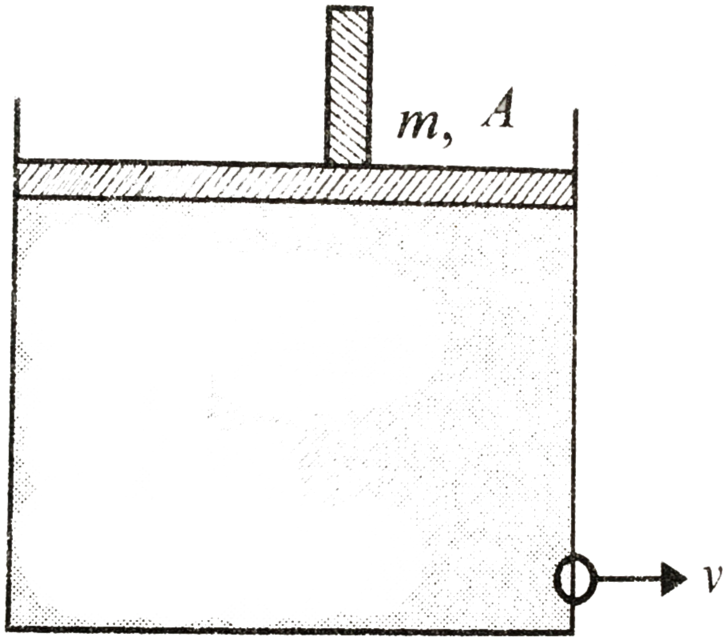
28. A cylindrical vessel contains a liquid of density ρ up to height h. The liquid is closed by a piston of mass m and area of cross section A. There is a small hole at the bottom of the vessel. The speed v with which the liquid comes out of the hole is



A. $\sqrt{2gh}$

B. $\sqrt{2g\left(h+\frac{m}{\rho A}\right)}$

C. $\sqrt{g\left(h+\frac{m}{\rho A}\right)}$

D. $\sqrt{g\left(h+\frac{2m}{\rho A}\right)}$

Answer: B

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29. Oil is filled in a cylindrical container up to height 4m. A small hole of area 'p' is punched in the wall of the container at a height 1.52m from the bottom. The cross sectional area of the container is

Q. If $\frac{p}{q} = 0.1$ then v is (where vis the velocity of oil coming out of the hole)

A. $5\sqrt{2}$

B. $6\sqrt{3}$

C. $8\sqrt{2}$

D. $7\sqrt{5}$

Answer: A

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30. Figure shows a liquid flowing through a tube at the rate of $0.1m^3/s$. The tube is branched into two semicircular tubes of cross - sectional area A/3 and 2A/3. The velocity of liquid at Q is (the cross-section of the main tube is $A = 10^{-2}m^2$ and $v_p = 20m/s$)

A. 5 m/s

B. 30 m/s

C. 35 m/s

D. None of these

Answer: A

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31. A cylinder of height 20m is completely filled with water. The velocity of effux of water $\left(\in ms^{-1}\right)$ through a small hole on the side wall of the cylinder near its bottom is

A. 10 m/s

B. 20 m/s

C. 25.5 m/s

D. 5 m/s

Answer: B

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32. Atank is filled with water upto a height H. Water is allowed to come out of a hole P in one of the walls at a depth h below the surface of water (see fig.) Express the horizontal distance X in terms Hand h.

A. $X = \sqrt{h(H-h)}$

B. $\left(X\sqrt{\frac{h}{2}(H-h)}\right.$

C. $\left(X = 2\sqrt{h(H-h)}\right.$

D. $X = 4\sqrt{h(H-h)}$

Answer: C

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33. There is a small hole at the bottom of tank filled with water. If total pressure at the bottom is $3atm\left(1atm = 10^5 Nm^{-2}\right)$, then find the velocity of water flowing from hole.

A. $\sqrt{400}m/s$

B. $\sqrt{600}m/s$

C. $\sqrt{60}m/s$

D. None of thtese

Answer: A

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34. In the figure, the velocity V_2 will be

A. Zero

B. $4ms^{-1}$

C. $1ms^{-1}$

D. $3ms^{-1}$

Answer: C

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35. Three tubes X, Y and Z are connected to a horizontal pipe in which ideal liquid is flowing. The radii of the tubes X, Y and Z at the junction are respectively 3 cm, 1 cm and 3 cm. It can be said

A. the height of the liquid in the tube A is maximum.

B. the height of liquid in the tubes Aand B is same.

C. the height liquid in the tubes A, B and C is same.

D. the height of the liquid in the tubes A and C is the same.

Answer: D

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36. Air flows horizontally with a speed v= 106 km/hr.

A house has plane roof of area $A = 20m^2$ The magnitude of aerodynamic lift of the roof is

A. $1.127 \times 10^4 N$

B. $5.0 \times 10^4 N$

C. $1.127 \times 10^5 N$

D. $3.127 \times 10^4 N$

Answer: A

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

A. $\frac{2A}{\pi a^2}\sqrt{\frac{h}{g}}$

B. $\frac{\sqrt{2}A}{\pi a^2}\sqrt{\frac{h}{g}}$

C. $\frac{2\sqrt{2}A}{\pi a^2}\sqrt{\frac{h}{g}}$

D. $\frac{A}{\sqrt{2}\pi a^2}\sqrt{\frac{h}{g}}$

Answer: B

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38. Water is flowing through a horizontal tube having crosssectional areas of its two ends being A and A' such that the ratio All' is 5. If the pressure difference of water between the two ends is $3 \times 10^{5} Nm^{-2}$ the velocity of water with which it enters the tube will be (neglect gravity effects)

A. $5 ms^{-1}$

B. $10 ms^{-1}$

C. $25 ms^{-1}$

D. $50\sqrt{10} ms^{-1}$

Answer: A

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39. Which of the following statement(s) is/are true?

A. For gases, in general, viscosity increases with temperature

B. For liquids, viscosity varies directly with pressure

C. For gases, viscosity is independent of pressure

D. All of the above

Answer: D

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40. If the terminal speed of a sphere of gold (density $= 19.5 kg / m^3$) is $0.2 m / s$ in a viscous liquid (density $= 1.5 kg / m^3$), find the terminal speed of a sphere of silver (density $= 10.5 kg / m^3$) of the same size in the same liquid

A. 0.4 m/s

B. 0.133 m/s

C. 0.1 m/s

D. 0.2 m/s

Answer: C

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41. What is the velocity v of a metallic ball of radius r falling in a tank of liquid at the instant when its acceleration is one-half that of a freely falling body ? (The densities of metal and of liquid are r and s respectively, and the viscosity of the liquid is η).

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

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

C. $\dfrac{r^2 g}{9\eta}(\rho - \sigma)$

D. $\dfrac{2r^2 g}{9\eta}(\rho - \sigma)$

Answer: C

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42. A rain drop of radius 0.3 mm has a terminal velocity in $\text{air} = 1\text{m/s}$. The viscosity of air is 8×10^{-5} poise. The viscous force on it is

A. 45.2×10^{-4} dyne

B. $101.73 \times 10^{-5}1$ dyne

C. 16.95×10^{-4} dyne

D. 16.96×10^{-5} dyne

Answer: A

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43. A spherical ball of iron of radius 2 mm is falling through a column of glycerine. If densities of glycerine and iron are respectively $1.3 \times 103\text{kg/m}^3$ and$8 \times 103\text{kg/m}^3$. η for glycerine = 0.83Nm^{-2} sec, then the terminal velocity

A. $0.7m/s$

B. $0.07m/s$

C. $0.007m/s$

D. $0.0007m/s$

Answer: B

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

A. v

B. $v/4$

C. v/2

D. 2v

Answer: C

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45. Two drops of the same radius are falling through air with a steady velcoity of $5cms^{-1}$. If the two drops coalesce, the terminal velocity would be

A. 10 cm per sec

B. 2.5 cm per sec

C. $5 \times (4)^{1/3}$ cm per sec

D. $5 \times \sqrt{3}$ cm per sec

Answer: C

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

A. `

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B. `

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C. `

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D. `

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Answer: B

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47. When a ball is released from rest in a very long column of viscous. Liquid its downwards acceleration is a (just after release). Then its acceleration when it has acquired two third of the maximum velocity:

A. 2

B. 3

C. 4

D. 5

Answer: C

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48. A ball of radius r and density p falls freely under gravity through a distance h before entering water. Velocity of ball does not change even on entering water. If viscosity of water is n the value of his given by

A. $\frac{2}{9} r^2 \left(\frac{1-\rho}{\eta}\right) g$

B. $\frac{2}{81} r^2 \left(\frac{\rho-1}{\eta}\right) g$

C. $\frac{2}{81} r^4 \left(\frac{\rho-1}{\eta}\right)^2 g$

D. $\frac{2}{9} r^4 \left(\frac{\rho-1}{\eta}\right)^2 g$

Answer: B

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49. A small ball (mass m) falling under gravity in a viscous medium experience a drag force proportional to the instantaneous speed u such that $F_{drag} = ku$. Then the terminal speed of ball within viscous medium is

A. $\frac{K}{mg}$

B. $\frac{mg}{K}$

C. $\sqrt{\frac{mg}{K}}$

D. $\left(\frac{mg}{K}\right)^2$

Answer: D

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50. An air bubble of radius 1 cm rises with terminal velocity 0.21 cm/s in liquid column. If the density of liquid is $1.47 \times 10^3 kg / m^3$. Then the value of coefficient of viscosity of liquid ignoring the density of air, will be

A. 1.71×10^4 poise

B. 1.82×10^4 poise

C. 1.78×10^4 poise

D. 1.52×10^{4} poise

Answer: D

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51. Two soap bubbles A and B are kept in a closed chamber where the air is maintained at pressure $8N/m^2$. The radii of bubbles A and B are $2cm$ and $4cm$, respectively. Surface tension of the soap. Water used to make bubbles is $0.04N/m$. Find the ratio n_B/n_A, where n_A and n_B are the number of moles of air in bubbles A and B respectively.

[Neglect the effect of gravity.]

A. 2

B. 9

C. 8

D. 6

Answer: D

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52. Let T_1 be surface tension between solid and air, T_2 be the surface tension between solid and liquid and T be the surface tension between liquid and air. Then in equilibrium, for a drop of liquid on a clean glass plate, the relation is (θ is angle of contact)

A. $\cos\theta = \frac{T}{T_1 + T_2}$

B. $\cos\theta = \frac{T}{T_1 - T_2}$

C. $\cos\theta = \frac{T_1 T_2}{T}$

D. $\cos\theta = \frac{T_1 - T_2}{T}$

Answer: A

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53. An isolated and charged spherical soap bubble has a radius r and the pressure inside is atmospheric. IfT is the surface tension of soap solution, then charge on drop is$X\pi\sqrt{2rT\varepsilon_0}$ then find the value of X.

A. 8

B. 9

C. 7

D. 2

Answer: A

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54. The rise in the water level in a capillary tube of radius 0.07 cm when dipped veryically in a beaker containing water of surface tension $0.07Nm^{-1}$ is (g = $10ms^{-2}$)

A. 2 cm

B. 4 cm

C. 1.5 cm

D. 3 cm

Answer: D

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55. If two glass plates have water between them and are separated by very small distance (see figure), it is very difficult to pull them apart. It is because the water in between forms cylindrical surface on the side that gives rise to lower pressure in the water in comparison to atmosphere. If the radius of the cylindrical surface is R and surface tension of water is T then the pressure in water between the plates is lower by

A. $\frac{2T}{R}$

B. $\frac{4T}{R}$

C. $\frac{T}{4R}$

D. $\frac{T}{R}$

Answer: C

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56. Water rises to a height of 10 cm in capillary tube and mercury falls to a depth of 3.112 cm in the same capillary tube. If the density of mercury is 13.6 and the angle of contact for mercury is 135°, the ratio of surface tension of water and mercury is

A. $1:0.15$

B. $1:3$

C. $1:6$

D. $1.5:1$

Answer: C

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57. A water film is formed between two parallel wires of 10 cm length. The distance of 0.5 cm between the wires is increased by 1mm. What will be the work done ? (Given, surface tension of water of $72 \times 10^{-3} Nm^{-1}$)

A. 36 erg

B. 288 erg

C. 144 erg

D. 72 erg

Answer: B

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58. A film of water is formed between two straight parallel wires of length 10 cm each separated by $0.5cm$ If their separation is increased by $1mm$ while still maintaining their parallelism, how much work will have to be done (Surface tension of water $= 7.2 \times 10^{-2} \frac{N}{m}$)

A. 7.22×10^{-6} joule

B. 1.44×10^{-5} joule

C. 2.88×10^{-5} joule

D. 5.76×10^{-5} joule

Answer: B

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59. A glass capillary tube of inner diameter 0.28 mm is lowered vertically into water in a vessel. The pressure to be applied on the water in the capillary tube so that water level in the tube is same as the vessel in $\frac{N}{m^2}$ is (surface tension of water $= 0.07\frac{N}{m}$ atmospheric pressure $= 10^5 \frac{N}{m^2}$

A. 10^3

B. 99×10^3

C. 100×10^3

D. 101×10^3

Answer: B

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Exercise 2 Concept Applicator

1. Two pieces of metals are suspended from the arms of a balance and are found to be in equilibrium when kept immersed in water. The mass of one piece is 32 g and its density 8g cm^{-3}.

The density of the other is $5 \mathrm{g} \text{ per } \mathrm{cm}^3$. Then the mass of the other is

A. 28 g

B. 35 g

C. 21 g

D. 33.6

Answer: B

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2. Air of density $1.2kgm^{-3}$ is blowing across the horizontal wings of an aeroplane in such a way that its speeds above and below the wings are $150ms^{-1}$ and $100ms^{-1}$, respectively. The pressure difference between the upper and lower sides of the wings, is :

A. $60Nm^{-2}$

B. $180Nm^{-2}$

C. $7500Nm^{-2}$

D. $12500Nm^{-2}$

Answer: C

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3. Suppose the average mass of raindrops is $3.0 \times 10^{-5} kg$ and their average terminal velocity $9 ms^{-1}$. Calculate the energy transferred by rain to each square metre of the surface at the place which receives 100 cm of rain in a year.

A. $23.5 \times 10^5 J$

B. $4.05 \times 10^4 J$

C. $3.0 \times 10^5 J$

D. $9.0 \times 10^4 J$

Answer: B

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4. A ring is cut from a platinum tube $8.5cm$ internal and $8.7cm$ external diameter. It is supported horizontally from the pan of a balance, so that it comes in contact with the water in a glass vessel. If an extra $3.103g.f.$ is required to pull it away from water, the surface tension of water is

A. 72 dyne cm^{-1}

B. 70.80 dyne cm^{-1}

C. 63.35 dyne cm^{-1}

D. 60 dyne cm^{-1}

Answer: A

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5. A boat with base area $8m^2$ floating on the surface of a still river is intended to move with a constant speed of 2 m/s by the application of a horizontal force. If the river bed is 2m deep find the force needed, (assuming a constant velocity gradient) Coefficient of viscosity of water is 0.90×10^{-2} poise.

A. 729 dyne

B. 620 dyne

C. 520 dyne

D. 360 dyne

Answer: A

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6. A vessel in the shape of a hollow hemisphere surmounted by a once is held with the axis vertical and vertex uppermost. If it be filled with a liquid so as to submerge half the axis of the cone in the liquid, and the height of the cone be double the radius of its base, find the liquid on the vessel is x times the weight of the liquid that the hemisphere can hold.

A. $15/8$

B. $1/8$

C. $5/8$

D. $15/2$

Answer: A

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7. Two liquids of densities d_1 and d_2 are flowing in identical capillaries under same pressure difference. If t_1 and t_2 are the time taken for the flow of equal quantities of liquid, then the ratio of coefficients of viscosities of liquids must be

A. $\frac{d_1 t_1}{d_2 t_2}$

B. $\frac{t_1}{t_2}$

C. $\frac{d_2}{d_1} \frac{t_2}{t_1}$

D. $\sqrt{\frac{d_1 t_1}{d_2 t_2}}$

Answer: A

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8. Water rises in a capillary tube to a certain height such that the upward force due to surface tension is balanced by 75×10^{-4} newton force due to the weight of the liquid. If the surface tension of water is $6 \times$ 10^-2` newton/metre the inner circumference of the capillary must be:

A. $1.25 \times 10^{-2} m$

B. $0.50 \times 10^{-2} m$

C. $6.5 \times 10^{-2} m$

D. $12.5 \times 10^{-2} m$

Answer: A

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9. Two spherical soap bubble coalesce. If V is the consequent change in volume of the contained air and S the change in total surface area, show that

$3PV + 4ST = 0$

where T is the surface tension of soap bubble and

P is

Atmospheric pressure

A. $4PV + 3ST = 0$

B. $3PV + 4ST = 0$

C. $2PV + 3ST = 0$

D. $3PV + 2ST = 0$

Answer: B

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10. A tank and a trough are placed on a trolley as shown. Water issues from the tank through a 5 cm. diameter nozzle at 5m/s and strikes the through which turns it by 45° as shown. Determine the compression of the spring of stiffnes 20N cm.

A. $1.74cm$

B. $1.12cm$

C. $0.78cm$

D. $2.12cm$

Answer: A

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11. A solid hemisphere of radius a and weight W is floating in liquid and at a point on the base at a distance c from the centre rests a weight w. The tangent of the inclination of the axis of the hemisphere to the vertical for the corresponding position of equilibrium is . [assuming the base of the hemisphere to be entirely out of the fluid]

A. $\frac{4}{3}\frac{c}{a}\frac{w}{W}$

B. $\frac{2}{3}\frac{c}{a}\frac{w}{W}$

C. $\frac{8}{3}\frac{c}{a}\frac{w}{W}$

D. $\frac{8}{5}\frac{c}{a}\frac{w}{W}$

Answer: C

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12. Two solid spherical balls of radii r_1 and $r_2(<r_1)$ and of density σ are tied up with a long string and released in a viscous liquid column of lesser density ρ with the string just tatu as shown. The tension in the string when terminal velocity is attained is

A. $\frac{4}{3}\pi\left(\frac{r_2^4 - r_1^4}{r_2 - r_1}\right)(\sigma - \rho)g$

B. $\frac{2}{3}\pi\left(r_2^3 - r_1^3\right)(\rho - \sigma)g$

C. $\frac{4}{3}\left(r_2^3 - r(1)^3\right)(\sigma - \rho)g$

D. $\frac{4}{3}\pi\left(\frac{r_2^4 - r_1^4}{r_2 + r_1}(\sigma - \rho)g\right.$

Answer: D

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13. A steel ball of diameter $d = 3.0mm$ starts sinking with zero initial velocity in olive oil whose viscosity is $\eta = 0.90P$. How soon after the beginning of motion will the velocity of the ball differ from the steady-state velocity by $n = 1.0\,\%$?

A. $0.2\,\text{sec.}$

B. $0.8\,\text{sec.}$

C. $0.6\,\text{sec.}$

D. $1.\ 2\,\text{sec.}$

Answer: A

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14. Two parallel glass plates are dipped partly in the liquid of density d keeping them vertical. If the distance between the plates is x surface tension for the liquid is T and angle of contact θ, then rise of liquid between the plates due to capillary will be

A. $\frac{T\cos\theta}{xd}$

B. $\frac{2T\cos\theta}{xeg}$

C. $\frac{2T}{xdg\cos\theta}$

D. $\frac{T\cos\theta}{xdg}$

Answer: B

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15. Water rises upto a height x in capillary tube immersed vertically in water . When this whole arrangement is taken to a depth d in a mine , the water level rises upto a height y . If R is the radius of the earth , then the ration $\frac{x}{y}$ is given by

A. $\left(1-\frac{d}{R}\right)$

B. $\left(1-\frac{2d}{R}\right)$

C. $\left(\frac{R-d}{R+d}\right)$

D. $\left(\frac{R+d}{R-d}\right)$

Answer: A

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16. A jar is folled with two non-mixing liquids 1 and 2 having densities ρ_1 and , ρ_2 respectively. A solid ball, made of a material of density ρ_3, is dropped in the jar. It comes to equilibrium in the position shown in the figure. Which of the following is true for ρ_1, ρ_2 and ρ_3 ?

A. $\rho_3 < \rho_1 < \rho_2$

B. $\rho_1 > \rho_3 > \rho_2$

C. $\rho_1 < \rho_2 < \rho_3$

D. $\rho_1 < \rho_3 < \rho_2$

Answer: D

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17. A vessel with water is placed on a weighing pan and it reads 600 g. Now a ball of mass 40 g and density $0.80 gcm^{-3}$ is sunk into the water with a pin of negligible volume, as shown in figure keeping in sunk. The weighting pan will show a reading

A. 600 g

B. 550 g

C. 650 g

D. 632 g

Answer: C

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18. Water is flowing at a speed of $1.5ms^{-1}$ through horizontal tube of cross-sectional area $10^{-2}m^2$ and you are trying to stop the flow by your palm. Assuming that the water stops immediately after hitting the palm, the minimum force that you must every should be

(density of water $= 10^3 kgm^{-3}$)

A. 15 N

B. $22.5N$

C. $33.7N$

D. $45N$

Answer: A

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19. Consider a water jar of radius R that has water filled up to height H and is kept on a stand of height h (see figure). Through a hole of radius r $(r < \, < R)$ at its bottom, the water leaks out and the stream of water coming down towards the ground has a shape like a funnel as shown in the figure. IF the radius of the cross-section of water stream when it hits the ground is x. Then:

A. $x = r\left(\frac{H}{H+h}\right)^{\frac{1}{4}}$

B. $x = r\left(\frac{H}{H+h}\right)$

C. $x = r\left(\frac{H}{H+h}\right)^{2}$

D. $x = r\left(\frac{H}{H+h}\right)^{\frac{1}{2}}$

Answer: A

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20. I a cylindrical water tank, there are two small holes A and B on the wall at a depth of h_1, from the surface of water and at a height of h_2 from the bottomof water tank. Surface of water is at height of h_2 from the bottom of water tank. Surface of water is at height H from the bottom of water tank. Water coming out from both holes strikes the ground at the same point S. FInd the ratio of h_1 and h_2

A. Depends on H

B. $1:1$

C. $2:2$

D. $1:2$

Answer: A

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21. A large number of liquid drops each of radius 'a' coalesce to form a single spherical drop of radish b. The energy released in the process is converted into kinetic energy of the big drops formed. The speed of big drop will be

A. $\sqrt{\frac{T}{\rho}\left(\frac{1}{r}-\frac{1}{R}\right)}$

B. $\sqrt{\frac{2T}{\rho}\left(\frac{1}{r}-\frac{1}{R}\right)}$

C. $\sqrt{\frac{4T}{\rho}\left(\frac{1}{r}-\frac{1}{R}\right)}$

D. $\sqrt{\frac{6T}{\rho}\left(\frac{1}{r}-\frac{1}{R}\right)}$

Answer: D

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22. Water flows in a streamline manner through a capillary tube of radius a. The pressure difference being P and the rate of flow is Q . If the radius is reduced to $a/2$ and the pressure difference is increased to 2P, then find the rate of flow.

A. 4Q

B. Q

C. $\frac{Q}{2}$

D. $\frac{Q}{8}$

Answer: D

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23. A space $2.5cm$ wide between two large plane surface is filled with oil. Force required to drag a very thin plate of area $0.5m^2$ just midway the surfaces at a speed of $0.5m/\text{sec.}$ Is 1N. The coefficient of viscosity in $kg-\text{sec}/m^2$ is

A. 5×10^{-2}

B. 2.5×10^{-2}

C. 1×10^{-2}

D. 7.5×10^{-2}

Answer: B

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24. A long cylinder of radius R_1 is displaced along its axis with a constant velocity v_0 inside a stationary co-axial cylinder of radius R_2. The space between the cylinders is filled with viscous liquid. Find the velocity of the liquid as a function of the distance r from the axis of the cylinders. The flow is laminar.

A. $2v_0 \dfrac{\ln(r/R_2)}{\ln(R_1/R_2)}$

B. $\dfrac{v_0}{2} \dfrac{\ln(r/R_2)}{(R_1/R_2)}$

C. $v_0 \dfrac{\ln(r/R_2)}{(R_1/R_2)}$

D. $\dfrac{2v_0}{3} \dfrac{\ln(r/R_2)}{\ln(R_1/R_2)}$

Answer: C

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