PHYSICS

BOOKS - SUNIL BATRA 41 YEARS IITJEE PHYSICS (HINGLISH)

MECHANICAL PROPERTIES OF MATTER AND FLUIDS

Jee Main And Advanced

1. A wire of length L and cross sectional area A is made of a material of Young's modulus Y. If the wire is streched by an amount x, the work done is.....

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2. A solid sphere of radius R made of a material of bulk modulus K is surrounded by a liquid in a cylindrical container. A massless pistion of area A floats on the surface of the

liquid. When a mass M is placed on the piston to compress the liquid the fractional change in the radius of the sphere, $\delta R / R$, is .....

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3. A piece of metal floats on mercury. The coefficients of volume expansion of the metal and mercury are γ_1 and γ_2 respectively. If the temperatures of both mercury and the metal are increased by an amount ΔT, the fraction

of the volume of the metal submerged in mercury changes by the factor.....

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4. A horizontal pipeline carries water in a streamline flow. At a point along the pipe, where the cross- sectional area is $10cm^2$, the water velocity is $1ms^{-1}$ and the pressure is 2000 Pa. The pressure of water at another point where the cross-sectional area is $5cm^2$, is.....Pa. (Density of water $= 10^3 kg.\, m^{-3}$)

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5. A man is sitting in a boat which is floating in a pond. If the man drinks some water from the pond, the level of water in the pond decreases.

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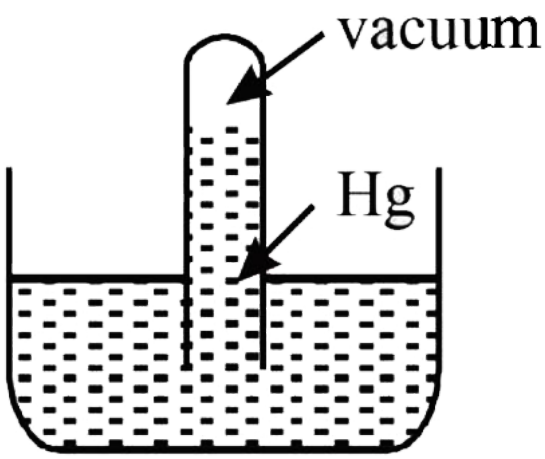
6. A barometer made of very narrow tuve (see fig) is placed at normal temperature and pressure. The coefficient of volume expansion of mercury is $0.00018 per C^{\circ}$ and that of the

tube is negligible. The temperature of mercury in the barometer is now raised by $1^{\circ}C$, but the temperature of the atmosphere does not raised by $1^{\circ}C$, but the temperature of the atmosphere does not change. Then the mercury height in the tube remains unchanged.



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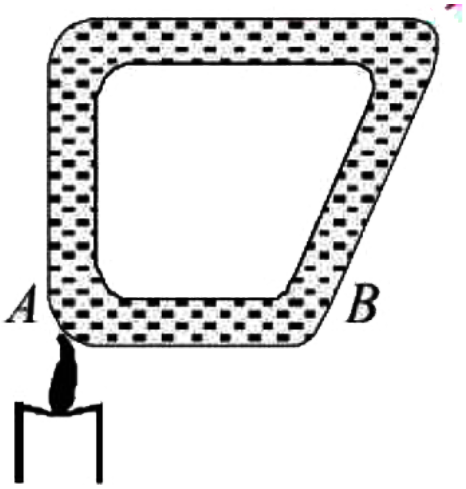
7. Water in a closed tube (see fig) is heated with one arm vertically placed above a lamp. Water will begin to circulate along the tube in counter-clockwise direction.



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8. A block of ice with a lead shot embedded in it is floating on water contained in a vessel. The temperature of the system is maintained at $0^{\circ}C$ as the ice melts. When the ice melts completely the level of water in the vessel rises.

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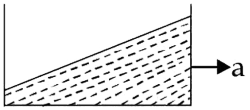
9. A vessel containing water is given a constant acceleration 'a' towards the right along a straight horizontal path. Which of the

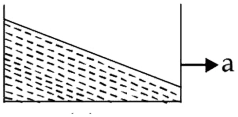
following diagrams in Fig. represents the surface of the liquid?

A. (a)

B. (b)



C. (c)



D. None of these

Answer: C

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10. The following four wires are made of the same material. Which of these will have the largest extension when the same tension is applied?

A. (a) length=50cm, diameter=0.5mm

B. (b) length=100cm, diameter=1mm

C. (c) length=200cm, diameter=2mm

D. (d) length=300cm, diameter=3mm

Answer: A

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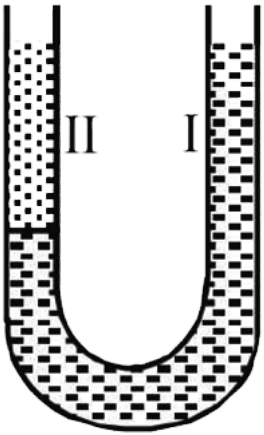
11. A U-tube of uniform cross section (see figure) is partially filled with a liquid I. Another liquid II which does not mix with liquid I is poured into one side. It is found that the liquid levels of the two sides of the tube are the same, while the level of liquid I has risen by 2cm. If the specific gravity of liquid I is 1.1,

the specific gravity of liquid II must be



A. (a) 1.12

B. (b) 1.1

C. (c) 1.05

D. (d) 1.0

Answer: B

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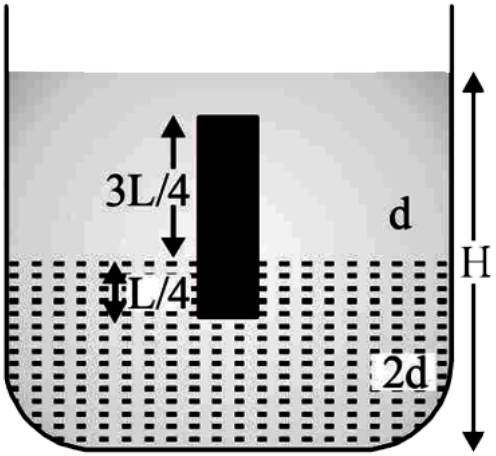
12. A homogeneous solid cylinder of length L(LltH/2), cross-sectional area A/5 is immersed such that it floats with its axis vertical at the liquid-liquid interface with length L/4 in the denser liquid as shown in the figure. The lower density liquid is open to atmosphere having

pressure P_0. Then density D of solid is given by



A. (a) $\frac{5}{4}d$

B. (b) $\frac{4}{5}d$

C. (c) $4d$

D. (d) $\frac{d}{5}$

Answer: A

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

A. (a) $\frac{L}{\sqrt{2\pi}}$

B. (b) $2\pi L$

C. (c) L

D. (d) $\frac{L}{2\pi}$

Answer: A

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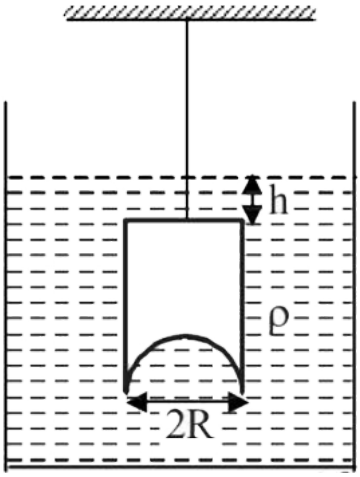
14. A hemispherical portion of radius R is removed from the bottom of a cylinder of radius R. The volume of the remaining cylinder is V and its mass M. It is suspended by a string

in a liquid of density ρ where it stays vertical. The upper surface of the cylinder is at a depth h below the liquid surface. The force on the bottom of the cylinder by the liquid is



A. (a) Mg

B. (b) $Mg - V\rho g$

C. (c) $Mg + \pi R^2 h\rho g$

D. (d) $\rho g\left(V+\pi R^2 h\right)$

Answer: D

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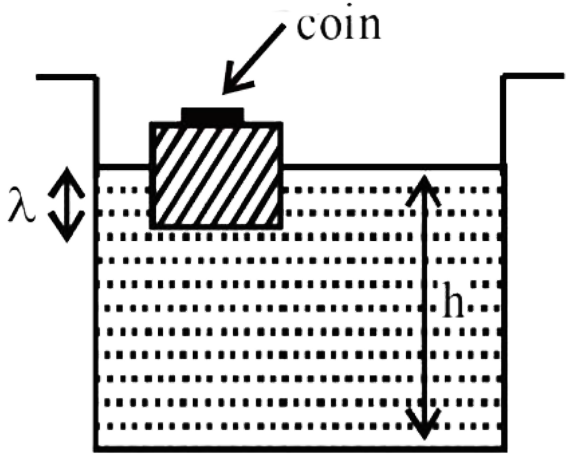
15. A wooden block, with a coin placed on its top, floats in water as shown in figure. The distance l and h are shown here. After some

time the coin falls into water. Then



A. (a) l decreases and h increases

B. (b) l increases and h decreases

C. (c) both l and h increase

D. (d) both l and h decrease

Answer: D

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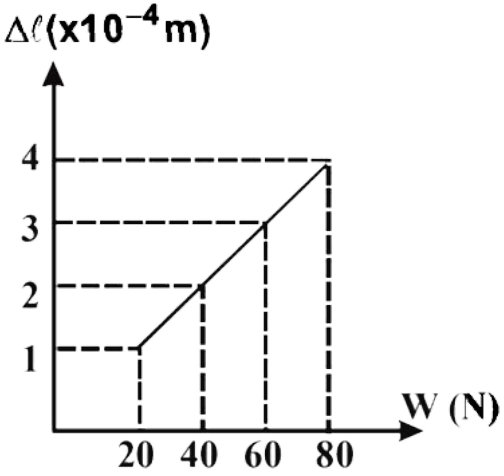
16. The adjacent graph shows the estension (Δl) of a wire of length 1m suspended from the top of a roof at one end and with a load W connected to the other end. If the cross-sectional area of the wire is $10^{-6}m^2$, calculate the Young's modulus of the material of the

wire.



A. (a) $2 \times 10^{11} N/m$

B. (b) $2 \times 10^{-11} N/m$

C. (c) $3 \times 10^{-12} N/m$

D. (d) $2 \times 10^{-13} N/m$

Answer: A

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17. Water is filled in a container upto height 3m. A small hole of area 'a' is punched in the wall of the container at a height 52.5 cm from the bottom. The cross sectional area of the container is A. If $a/A = 0.1$ then v^2 is (where v is the velocity of water coming out of the hole)

A. (a) 50

B. (b) 51

C. (c) 48

D. (d) 51.5

Answer: A

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18. When temperature of a gas is $20^{\circ}C$ and pressure is changed from $p_1 = 1.01 \times 10^5 Pa$ to $p_2 = 1.165 \times 10^5 Pa$ then the volume changed by $10\,\%$. The bulk modulus is

A. (a) $1.55 \times 10^5 Pa$

B. (b) $0.115 \times 10^5 Pa$

C. (c) $1.4 \times 10^5 Pa$

D. (d) $1.01 \times 10^5 Pa$

Answer: A

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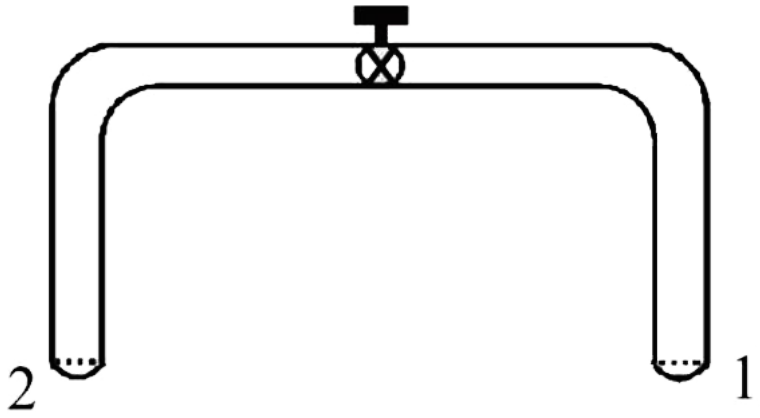
19. A glass tube of uniform internal radius(r) has a valve separating the two identical ends. Intially, the valve is in a tightly closed position.

End 1 has a hemispherical soap bubble or radius r. End 2 has sub-hemispherical soap bubble as shown in figure. Just after opening the valve,



A. (a) air from end 1 flows towards end 2. No change in the volume of the soap bubbles

B. (b) air from end 1 flows towards end 2. Volume of the soap bubble at end 1 decreases

C. (c) no changes occurs

D. (d) air from end 2 flows towards end 1. volume of the soap bubble at end 1 increases

Answer: B

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

A. (a) more than half-filled if ρ_c is less than 0.5

B. (b) more than half-filled if ρ_c is more than 1.0.

C. (c) half-filled if ρ_c is more than 0.5.

D. (d) less than half-filled if ρ_c is less than 0.5

Answer: A

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21. One end of a horizontal thick copper wire of length 2L and radius 2R is welded to an end fo another horizontal thin copper wire of lenth L and radius R. When the arrangement is

stretched by applying forces at two ends, the ratio of the elongation in the thin wire to that in the thick wire is

A. (a) 0.25

B. (b) 0.50

C. (c) 2.00

D. (d) 4.00

Answer: C

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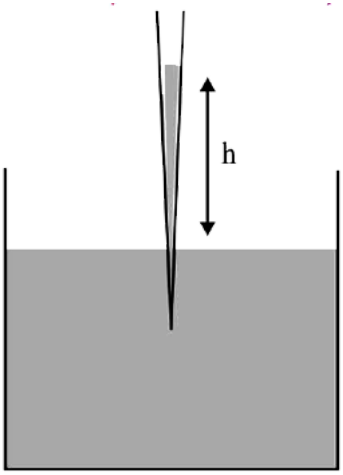
22. A glass capillary tube is of the shape of a truncated cone with an apex angle α so that its two ends have cross sections of different radii. When dipped in water vertically, water rises in it to a high h, where the radius of its cross section is b. If the surface tension of water is S, its density if ρ, and its contact angle with glass is θ, the value of h will be (g is the

acceleration due to gravity)



A. (a) $\frac{2S}{b\rho g}\cos(\theta - \alpha)$

B. (b) $\frac{2S}{b\rho g}\cos(\theta + \alpha)$

C. (c) $\frac{2S}{b\rho g}\cos(\theta - \alpha/2)$

D. (d) $\frac{2S}{b\rho g}\cos(\theta + a/2)$

Answer: D

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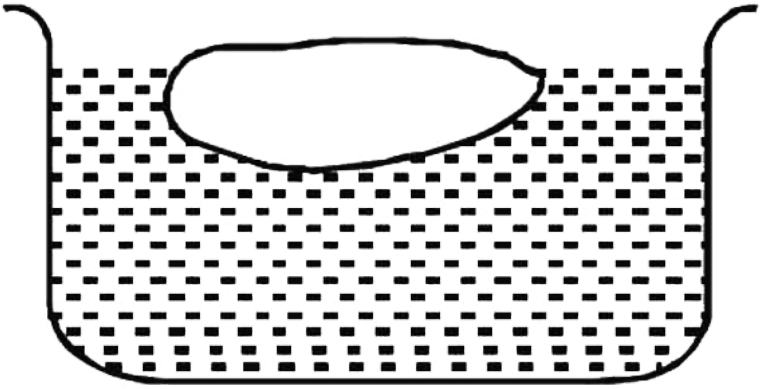
23. A body floats in a liquid contained in a beaker. The whole system as shown in Figure falls freely under gravity. The upthrust on the body is



A. (a) zero

B. (b) equal to the weight of the liquid displaced

C. (c) equal to the weight of the body in air

D. (d) equal to the weight of the immersed portion of the body

Answer: A

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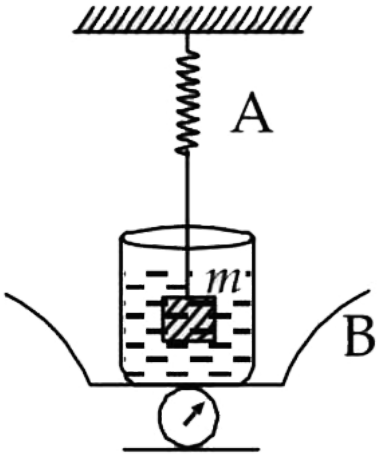
24. The spring balance A reads 2 kg with a block m suspended from it. A balance B reads 5kg when a beaker with liquid is put on the pan of the balance. The two balances are now so arranged that the hanging mass in inside the liquid in the beaker as shown in the figure. In this situation:



A. (a) the balance A will read more than 2 kg

B. (b) the balance B will read more than 5kg

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

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

Answer: B::C

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25. A vessel contains oil (density $= 0.8 gm / cm^3$) over mercury (density $= 13.6 gmcm^3$). 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. (a) 3.3

B. (b) 6.4

C. (c) 7.2

D. (d) 12.8

Answer: C

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26. Two rods of different materials having coefficients of thermal expansion α_1, α_2 and Young's modulii Y_1, Y_2 respectively are fixed between two rigid massive walls. The rods are heated such that they undergo the same increase in temperature. There is no bending of the rods. If $\alpha_1 : \alpha_2 = 2 : 3$, the thermal

stresses developed in the two rods are equal provided $Y_1 : Y_2$ is equal to

A. (a) 2:3

B. (b) 1:1

C. (c) 3:2

D. (d) 4:9

Answer: C

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

A. (a) $5.5 \times 10^{-4}m^2$

B. (b) $1.0 \times 10^{-5}m^2$

C. (c) `5.0xx10^-5m^2

D. (d) `2.0xx10^-5m^2

Answer: C

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28. A solid sphere of radius R and density ρ is attached to one end of a mass-less spring of force constant k. The other end of the spring is connected to another solid sphere of radius R and density 3ρ. The complete arrangement is placed in a liquid of density 2ρ and is

allowed to reach equilibrium. The correct statements(s) is (are)

A. (a) The net elongation of the spring is $\frac{4\pi R^3 \rho g}{3k}$

B. (b) The net elongation of the spring is $\frac{8\pi R \rho g}{3k}$

C. (c) The light sphere is partially submerged

D. (d) The light sphere is completely submerged

Answer: A::D

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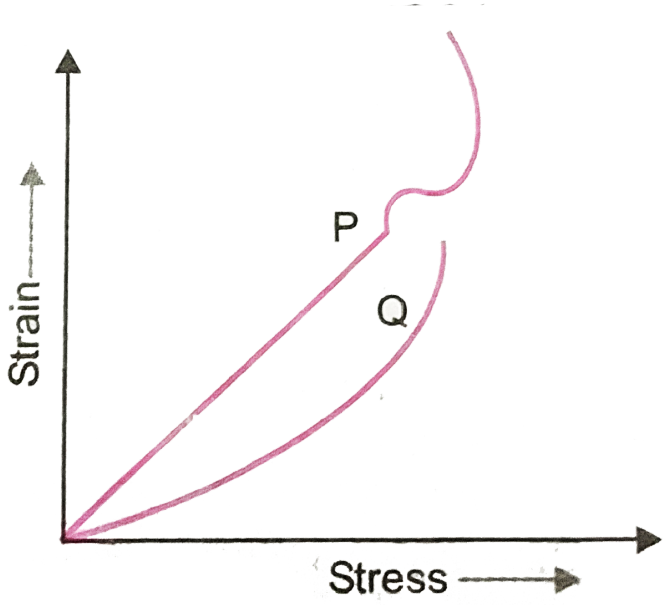
29. In plotting stress versus strain curves for two material P and Q, a student by mistake puts strain on the y-axis stress on ther x-axis as shown in the figure. Then the correct

statement is/are



A. (a) P has more tensile strength than Q

B. (b) P is more ductile than Q

C. (c) P is more brittle than Q

D. (d) The Young's modulus of P is more than that of Q

Answer: B::C

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30. A spherical body of radius R consists of a fluid of constant density and is in equilibrium under its own gravity. If P(r) is the pressure at r(rltR), then the correct option(s) is (are)

A. (a) $P(r=0)=0$

B. (b) $\frac{P(r=3R/4)}{P(r=2R/3)}=\frac{63}{80}$

C. (c) $\frac{P(r=3R/5)}{P(r=2R/5)}=\frac{16}{21}$

D. (d) $\frac{P(r=R/2)}{P(r=R/3)}=\frac{20}{27}$

Answer: A::B

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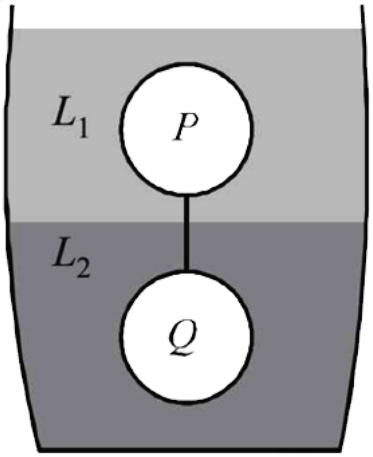
31. Two spheres P and Q of equal radii have densities ρ_1 and ρ_2, respectively. The spheres are connected by a massless string and placed

in liquids L_1 and L_2 of densities σ_1 and σ_2 and viscosities η_1 and η_2, respectively. They float in equilibrium with the sphere P in L_1 and sphere Q in L_2 and the string being taut(see figure). If sphere P alone in L_2 has terminal velocity $\overrightarrow{V}_p$ and Q alone in L_1 has terminal velocity $\overrightarrow{V}_Q$, then



A. (a) $\frac{\left|\overrightarrow{V}_P\right|}{\left|\overrightarrow{V}_Q\right|} = \frac{\eta_1}{\eta_2}$

B. (b) $\frac{\left|\overrightarrow{V}_P\right|}{\left|\overrightarrow{V}_Q\right|} = \frac{\eta_2}{\eta_1}$

C. (c) $\overrightarrow{V}_P . \overrightarrow{V}_Q > 0$

D. (d) $\overrightarrow{V} . \overrightarrow{V}_Q < 0$

Answer: A::D

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32. A column of mercury of 10cm length is contained in the middle of a narrow horizontal 1m long tube which is closed at both the ends. Both the halves of the tube contain air at a pressure of 76 cm of mercury. By what distance will the column of mercury be displaced if the tube is held vertically?

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33. A point mass m is suspended at the end of a massless wire of length l and cross section. If Y is the Young's modulus for the wire, obtain the frequency of oscillation for the simple harmonic motion along the vertical line.

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34. A cube of wood supporting 200gm mass just floats in water. When the mass is removed,

the cube ruses by 2cm. What is the size of the cube?

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35. A boat floating in a water tank is carrying a number of large stones. If the stones are unloaded into water, what will happen to the water level?

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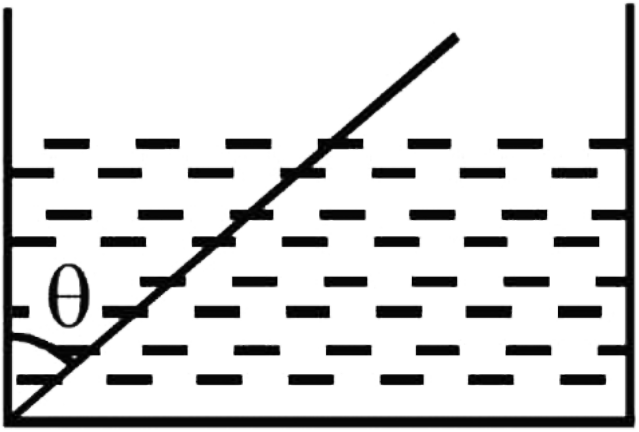
36. A wooden plank of length 1m and uniform cross-section is hinged at one end to the bottom of a tank as shown in fig. The tank is filled with water upto a hight 0.5m. The specific gravity of the plank is 0.5. Find the angle θ that the plank makes with the vertical in the equilibrium position. (Exclude the case

$\theta = \theta^\circ$)



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37. A ball of density d is dropped on to a horizontal solid surface. It bounces elastically from the surface and returns to its original position in a time t_1. Next, the ball is released

and it falls through the same height before striking the surface of a liquid of density of d_L

(a) If $d < d_L$, obtain an expression (in terms of d, t_1 and d_L) for the time t_2 the ball takes to come back to the position from which it was released.

(b) Is the motion of the ball simple harmonic?

(c) If $d = d_L$, how does the speed of the ball depend on its depth inside the liquid? Neglect all frictional and other dissipative forces. Assume the depth of the liquid to be large.

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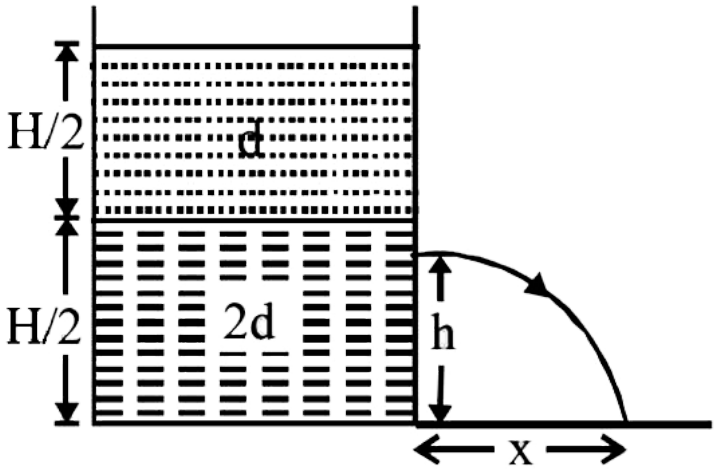
38. A container of large uniform cross-sectional area A resting on a horizontal surface, holds two immiscible, non-viscous and incompressible liquids of densities d and 2d, each of height H/2 as shown in the figure. The lower density liquid is open to the atmosphere having pressure P_0.



(a) A homogeneous solid cylinder of length $L(L < H/2)$, cross-sectional area $A/5$ is immersed such that it floats with its axis vertical at the liquid-liquid interface with length $L/4$ in the denser liquid. Determine:

(i) the density D of the solid and

(ii) the total pressure at the bottom of the container.

(b) The cylinder is removed and the original arrangement is restored. A tiny hole of area $s(s << A)$ is punched on the vertical side of the container at a height $h(h < H/2)$. Determine:

(i) the initial speed of efflux of the liquid at the hole,

(ii) the horizontal distance x travelled by the liquid initially, and

(iii) the height h_m at which the hole should be punched so that the liquid travels the maximum distance x_m initially. Also calculate x_m.

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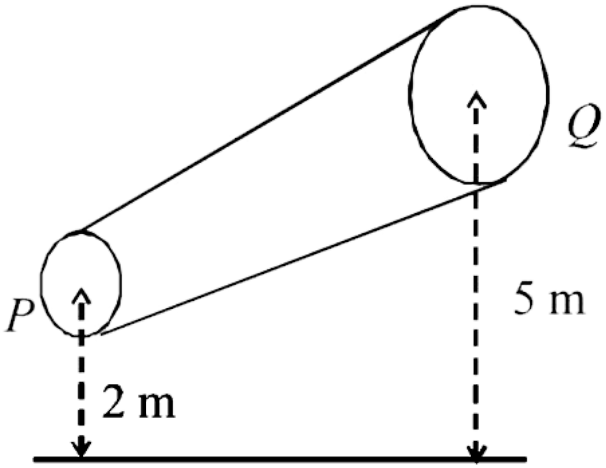
39. A non-viscous liquid of constant density $1000kg/m^3$ flows in a streamline motion along a tube of variable cross section. The tube is kept inclined in the vertical plane as shown in Figure. The area of cross section of the tube two point P and Q at heights of 2 metres and 5 metres are respectively $4 \times 10^{-3}m^2$ and $8 \times 10^{-3}m^2$. The velocity of the liquid at point P is $1m/s$. Find the work done per unit volume by the pressure and the gravity forces as the fluid flows from point P to

Q.



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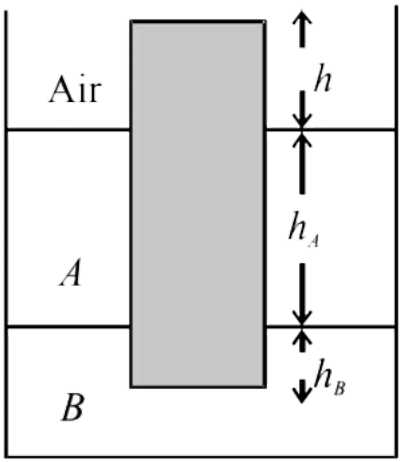
40. A uniform solid cylinder of density $0.8g/cm^3$ floats in equilibrium in a combination of two non-mixing liquids A and B with its axis vertical.

The densities of the liquids A and B are $0.7g/cm^3$ and $1.2g/cm^3$, respectively. The height of liquid A is $h_A = 1.2cm$. The length of the part of the cylinder immersed in liquid B is $h_B = 0.8cm$.



(a) Find the total force exerted by liquid A on the cylinder.

(b) Find h, the length of the part of the

cylinder in air.

(c) The cylinder is depressed in such a way that its top surface is just below the upper surface of liquid A and is then released. Find the acceleration of the cylinder immediately after it is released.

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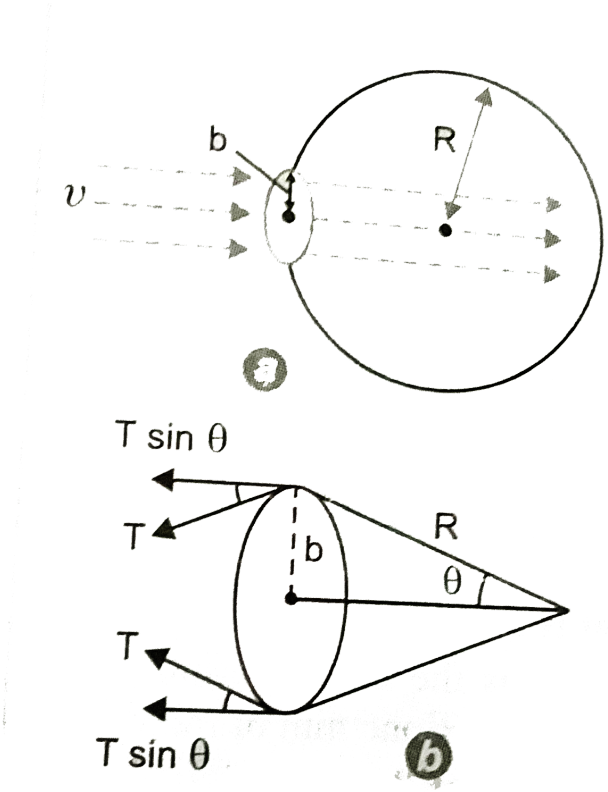
41. A bubble having surface tension T and radius R is formed on a ring of radius b $(b < > R)$. Air is blown inside the tube held

in front of the ring , with velocity v as shown in fig. The air molecules collides perpendicularly with the wall of the bubble and stops. Calculate the radius R at which the bubble and stops. Calculate the radius R at

which the bubble separates from the ring.



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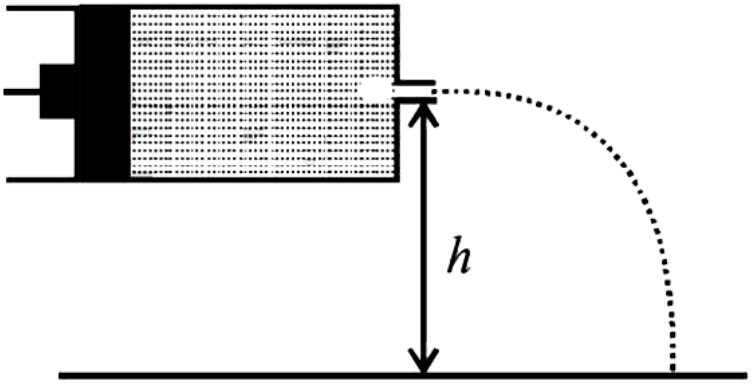
42. A tube has two area of cross-section as shown in figure. The diameters of the tube are 8mm and 2mm. Find range of water falling on horizontal surface, if pistion is moving with a constant velocity of $0.25m/s$, $h = 1.25m\left(g = 10m/s^2\right)$



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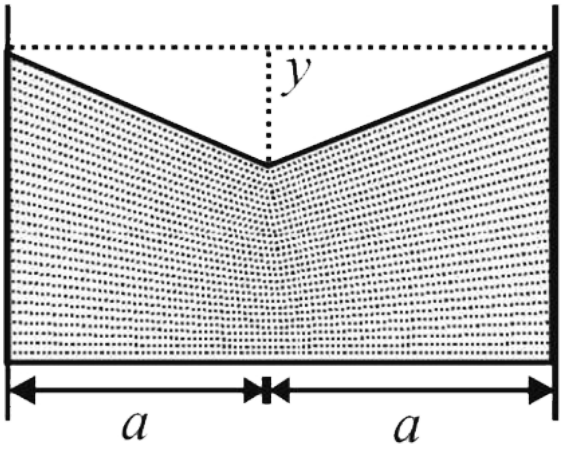
43. A uniform wire having mass per unit length λ is placed over a liquid surface. The wire causes the liquid to depress by $y(y << a)$ as shown in figure. Find surface tension of liquid. Neglect end effect.



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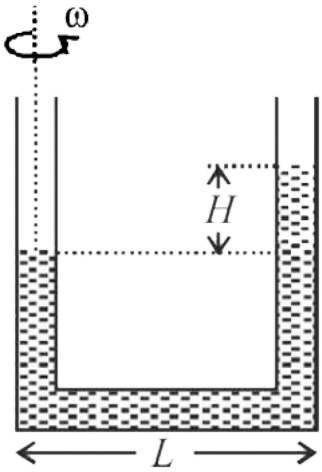
44. A U tube is rotated about one of it's limbs with an angular velocity ω. Find the difference in height H of the liquid (density ρ) level, where diameter of the tube $d << L$.



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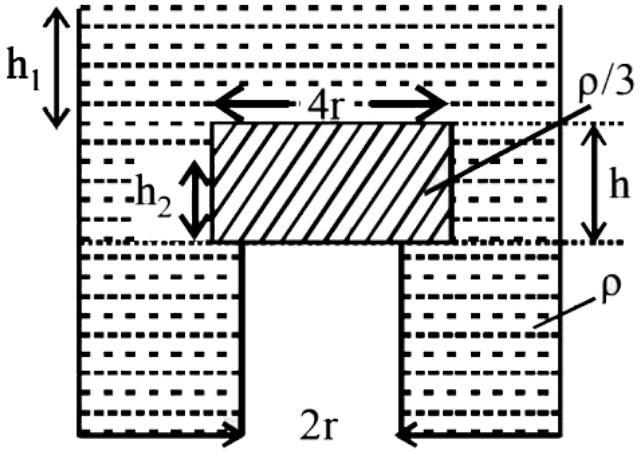
45. A cylindrical tank has a hole of diameter 2r in its bottom. The hole is covered wooden cylindrical block of diameter 4r, height h and density $\rho / 3$.



Situation I: Initially, the tank is filled with water of density ρ to a height such that the height of water above the top of the block is h_1

(measured from the top of the block).

Situation II: The water is removed from the tank to a height h_2 (measured from the bottom of the block), as shown in the figure. The height h_2 is smaller than h (height of the block) and thus the block is exposed to the atmosphere.

Find the minimum value of height h_1 (in situation 1), for which the block just starts to move up?

A. (a) $\frac{2h}{3}$

B. (b) $\frac{5h}{4}$

C. (c) $\frac{5h}{3}$

D. (d) $\frac{5h}{2}$

Answer: C

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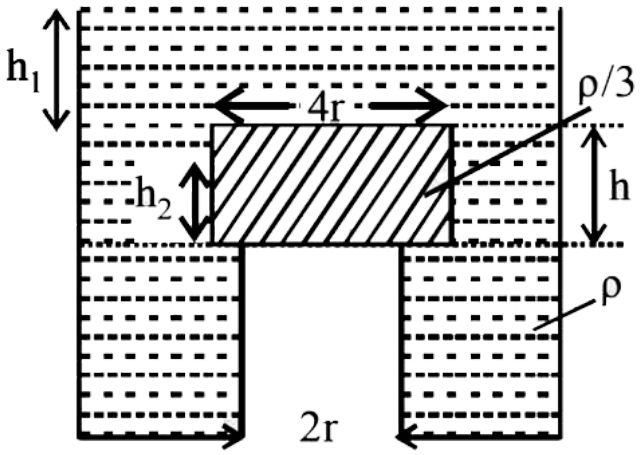
46. A cylindrical tank has a hole of diameter 2r in its bottom. The hole is covered wooden cylindrical block of diameter 4r, height h and density $\rho/3$.



Situation I: Initially, the tank is filled with water of density ρ to a height such that the height of water above the top of the block is h_1 (measured from the top of the block).

Situation II: The water is removed from the tank to a height h_2 (measured from the bottom of the block), as shown in the figure. The height h_2 is smaller than h (height of the

block) and thus the block is exposed to the atmosphere.

Find the height of the water level h_2 (in situation 2), for which the block remains in its origin) position whithout the application of any external force

A. (a) $\frac{h}{3}$

B. (b) $\frac{4h}{9}$

C. (c) $\frac{2h}{3}$

D. (d) h

Answer: B

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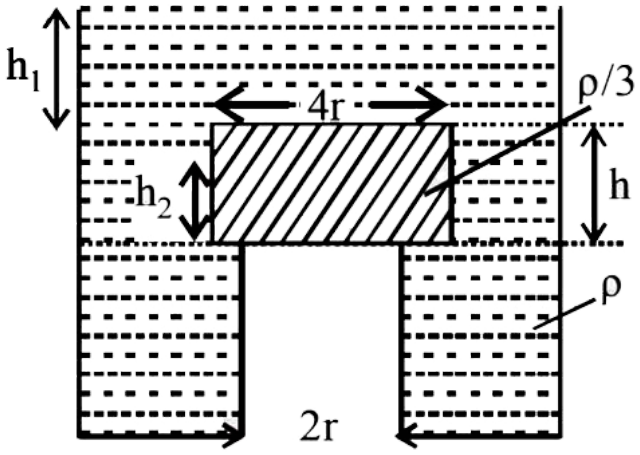
47. A cylindrical tank has a hole of diameter 2r in its bottom. The hole is covered wooden cylindrical block of diameter 4r, height h and density $\rho/3$.



Situation I: Initially, the tank is filled with water

of density ρ to a height such that the height of water above the top of the block is h_1 (measured from the top of the block).

Situation II: The water is removed from the tank to a height h_2 (measured from the bottom of the block), as shown in the figure. The height h_2 is smaller than h (height of the block) and thus the block is exposed to the atmosphere.

In situation 2, if h_2 is further decreased, then

A. (a) cylinder will not move up and remains at its original position

B. (b) for $h_2 = \frac{h}{3}$, cylinder again starts moving up

C. (c) for $h_2 = \frac{h}{4}$, cylinder again starts moving up

D. (d) for $h_2 = \frac{h}{5}$, cylinder again starts moving up

Answer: A

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48. When liquid medicine of density ρ is to put in the eye, it is done with the help of a dropper. As the bulp on the top of the dropper is pressed, a drop forms at the opening of the dropper. We wish to estimate the size of the drop. We first assume that the drop formed at the opening is spherical because that requires a minimum increase in its surface energy. To determine the size, we calculate the net vertical force due to the surface tension T when the radius of the drop is R. When this force becomes smaller than the weight of the

drop, the drop gets detached from the dropper.

If the radius of the opening of the dropper is r, the vertical force due to the surface tension on the drop of radius R (assuming r ltltR) is

A. (a) $2\pi rT$

B. (b) $2\pi RT$

C. (c) $\frac{2\pi r^T}{R}$

D. (d) $\frac{2\pi R^2 T}{r}$

Answer: C

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49. When liquid medicine of density ρ is to put in the eye, it is done with the help of a dropper. As the bulp on the top of the dropper is pressed, a drop forms at the opening of the dropper. We wish to estimate the size of the drop. We first assume that the drop formed at the opening is spherical because that requires a minimum increase in its surface energy. To determine the size, we calculate the net vertical force due to the surface tension T

when the radius of the drop is R. When this force becomes smaller than the weight of the drop, the drop gets detached from the dropper.

If $r = 5 \times 10^{-4} m$, $\rho = 10^3 kgm^{-3}$, $g = 10 ms^{-2}$, $T = 0.11 Nm^{-1}$, the radius of the drop when it detaches from the dropper is approximately

A. (a) $1.4 \times 10^{-3} m$

B. (b) $3.3 \times 10^{-3} m$

C. (c) $2.0 \times 10^{-3} m$

D. (d) $4.1 \times 10^{-3} m$

Answer: A

Watch Video Solution

50. When liquid medicine of density ρ is to put in the eye, it is done with the help of a dropper. As the bulp on the top of the dropper is pressed, a drop forms at the opening of the dropper. We wish to estimate the size of the drop. We first assume that the drop formed at

the opening is spherical because that requires a minimum increase in its surface energy. To determine the size, we calculate the net vertical force due to the surface tension T when the radius of the drop is R. When this force becomes smaller than the weight of the drop, the drop gets detached from the dropper.

After the drop detaches, its surface energy is

A. (a) $1.4 \times 10^{-6} j$

B. (b) $2.7 \times 10^{-6} J$

C. (c) $5.4 \times 10^{-6} J$

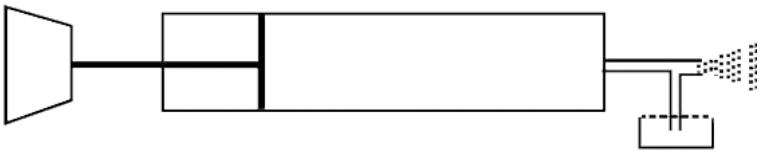
D. (d) $8.1 \times 10^{-6} J$

Answer: B

Watch Video Solution

51. A spray gun is shown in the figure where a piston pushes air out of a nozzle. A thin tube of uniform cross section is connected to the nozzle. The other end of the tube is in a small liquid container. As the piston pushes air through the nozzle, the liquid from the

container rises into the nozzle and is sprayed out. For the spray gun shown, the radii of the piston and the nozzle are 20mm and 1mm respectively. The upper end of the container is open to the atmosphere.



If the piston is pushed at a speed of $5mms^{-1}$, the air comes out of the nozzle with a speed of

A. (a) $0.1ms^{-1}$

B. (b) $1ms^{-1}$

C. (c) $2ms^{-1}$

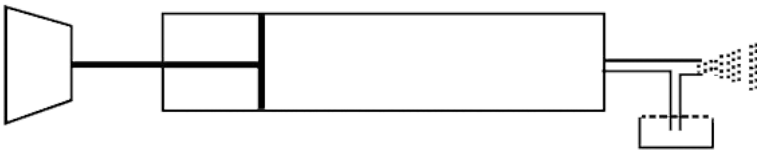
D. (d) $8ms^{-1}$

Answer: C

Watch Video Solution

52. A spray gun is shown in the figure where a piston pushes air out of a nozzle. A thin tube of uniform cross section is connected to the

nozzle. The other end of the tube is in a small liquid container. As the piston pushes air through the nozzle, the liquid from the container rises into the nozzle and is sprayed out. For the spray gun shown, the radii of the piston and the nozzle are 20mm and 1mm respectively. The upper end of the container is open to the atmosphere.



If the density of air is ρ_a, and that of the liquid ρ_l, then for a given piston speed the rate (volume per unit time) at which the liquid is sprayed will be proportional to

A. (a) $\sqrt{\frac{\rho_a}{\rho_l}}$

B. (b) $\sqrt{\rho_a \rho_l}$

C. (c) $\sqrt{\frac{\rho_l}{\rho_a}}$

D. (d) ρ_l

Answer: A

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53. STATEMENT-1: The stream of water flowing at high speed from a garden hose pipe tends to spread like a fountain when held vertically up, but tends to narrow down when held vertically down.

STATEMENT-2: In any steady flow of an incompressible fluid, the volume flow rate of the fluid remains constant.

A. (a) Statement-1 is True, Statement-2 is True, Statement-2 is a correct

explanation for Statement-1

B. (b) Statement-1 is True, Statement-2 is True, Statement-2 is NOT a correct explanation for Statement-1

C. (c) Statement-1 is True, Statement-2 is False

D. (d) Statement-1 is False, Statement-2 is True

Answer: A

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54. 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 tha 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.]

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55. A cylindrical vessel of height 500mm has an orifice (small hole) at its bottom. The orifice is initially closed and water is filled in it up to height H. Now the top is completely sealed with a cap and the orifice at the bottom is opened. Some water comes out from the orifice and the water level in the vessel becomes steady with height of water column being 200mm. Find the fall in height(in mm) of water level due to opening of the orifice.

[Take atmospheric pressure $= 1.0 \times 10^5 N/m^2$, density of

water=1000kg//m^3 and g=10m//s^2`. Neglect any effect of surface tension.]

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56. A $0.1kg$ mass is suspended from a wire of negligible mass. The length of the wire is 1m and its crosssectional are is $4.9 \times 10^{-7}m^2$. If the mass is pulled a little in the vertically downward direction and released, it performs simple harmonic motion of angular frequency $140rads^{-1}$. If the Young's modulus of the

material of the wire is $n \times 10^9 Nm^{-2}$, the value of n is

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57. Consider two solid spheres P and Q each of density $8gmcm^{-3}$ and diameters 1cm and 0.5cm, respectively. Sphere P is dropped into a liquid of density $0.8gmcm^{-3}$ and viscosity $\eta = 3$ poiseulles. Sphere Q is dropped into a liquid of density $1.6gmcm^{-3}$ and viscosity

$\eta = 2$ poiseulles. The ratio of the terminal velocities of P and Q is

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58. A spring of force constant $800N/m$ has an extension of 5cm. The work done in extending it from 5cm to 15cm is

A. (a) 16J

B. (b) 8J

C. (c) 32J

D. (d) 24J

Answer: B

Watch Video Solution

59. A wire fixed at the upper end stretches by length l by applying a force F. The work done in stretching is

A. (a) 2Fl

B. (b) Fl

C. (c) $\frac{F}{2l}$

D. (d) $\frac{Fl}{2}$

Answer: D

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60. Spherical balls of radius 'R' are falling in a viscous fluid of viscosity $'\eta'$ with a velocity 'v'. The retarding viscous force acting on the spherical ball is

A. (a) inversely proportional to both radius 'R' and velocity 'v'

B. (b) directly proportional to both radius 'R' and 'velocity 'v'

C. (c) directly proportional to 'R' but inversely proportional to 'v'

D. (d) inversely proportional to 'R' but directly proportional to velocity 'v'

Answer: B

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

A. (a) air flows from the smaller bubble to the bigger

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

C. (c) air flows from the bigger bubble to the smaller bubble till the sizes become

equal

D. (d) there is no flow of air

Answer: A

62. If 'S' is stress and 'Y' is young's modulus of material of a wire, the energy stored in the wire per unit volume is

A. (a) $\frac{S^2}{2Y}$

B. (b) $2S^2Y$

C. (c) $\frac{S}{2Y}$

D. (d) $\frac{2Y}{S^2}$

Answer: A

Watch Video Solution

63. A 20cm long capillary tube is dipped in water. The water rises up to 8cm. If the entire arrangement is put in a freely falling elevator

the length of water column in the capillary tube will be

A. (a) 10cm

B. (b) 8cm

C. (c) 20cm

D. (d) 4cm

Answer: C

 Watch Video Solution

64. A wire elongates by l mm when a load W is hanged from it. If the wire goes over a pulley and two weights W each are hung at the two ends, the elongation of the wire will be (in mm)

A. (a) l

B. (b) 2l

C. (c) zero

D. (d) $\frac{l}{2}$

Answer: A

Watch Video Solution

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

A. (a) $0.4m/s$

B. (b) $0.133m/s$

C. (c) $0.1m/s$

D. (d) $0.2m/s$

Answer: C

Watch Video Solution

66. 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. (a) $\sqrt{\frac{Vg(\rho_1 - \rho_2)}{k}}$

B. (b) $\frac{Vg\rho_1}{k}$

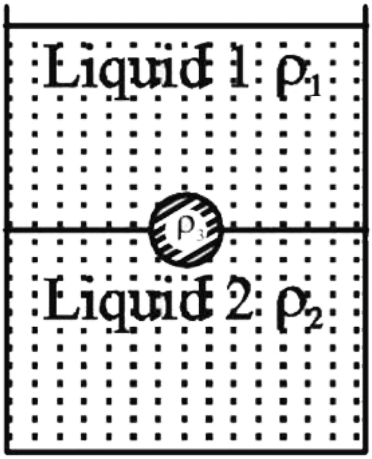
C. (c) $\sqrt{\frac{Vg\rho_1}{k}}$

D. (d) $\frac{Vg(\rho_1 - \rho_2)}{k}$

Answer: A

Watch Video Solution

67. A jar is filled with two non-mixing liquids 1 and 2 haivng 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_1 and ρ_3?



A. (a) $\rho_3 < \rho_1 < \rho_2$

B. (b) $\rho_1 > \rho_3 > \rho_2$

C. (c) $\rho_1 < \rho_2 < \rho_3$

D. (d) $\rho_1 < \rho_3 < \rho_2$

Answer: D

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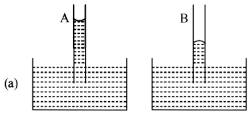
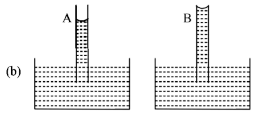
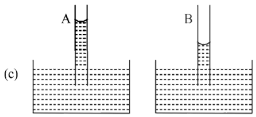
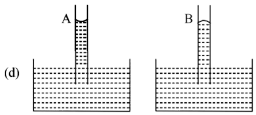
68. A capillary tube (A) is dipped in water. Another identical tube (B) is dipped in a soap-water solution. Which of the following shows

the relative nature of the liquid columns in the two tubes?

A. 

B. (b) 

C. (c) 

D. (d) 

Answer: C

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69. Two wires are made of the same material and have the same volume. However wire 1 has cross-sectional area A and wire 2 has cross-sectional area 3A. If the length of wire 1 increases by Δx on applying force F, how much force is needed to stretch wire 2 by the same amount?

A. (a) 4F

B. (b) 6F

C. (c) 9F

D. (d) F

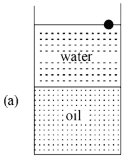
Answer: C

Watch Video Solution

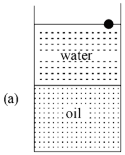
70. A ball is made of a material of density ρ where $\rho_{oil} < \rho < \rho_{water}$ with ρ_{oil} and ρ_{water} representing the densities of oil and water, respectively. The oil and water are immiscible. If the above ball is in equilibrium in a mixture

of this oil and water, which of the following pictures represents its equilibrium position?

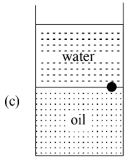
A. (a)



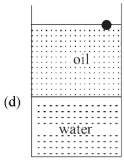
B. (b)



C. (c)



D. (d)



Answer: B

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71. Two identical charged spheres are suspended by strings of equal lengths. The strings make an angle of 30° with each other. When suspended in a liquid of density $0.8gcm^{-3}$, the angle remains the same. If density of the material of the sphere is $1.6gcm^{-3}$, the dielectric constant of the liquid is

A. (a) 4

B. (b) 3

C. (c) 2

D. (d) 1

Answer: C

 Watch Video Solution

72. Work done in increasing the size of a soap bubble from a radius of 3cm to 5cm is nearly (Surface tension of soap solution $= 0.03Nm^{-1}$)

A. (a) $0.2\pi mJ$

B. (b) $2\pi mJ$

C. (c) $0.4\pi mJ$

D. (d) $4\pi mJ$

Answer: C

Watch Video Solution

73. Water is flowing continuously from a tap having an internal diameter $8 \times 10^{-3} m$. The water velocity as it leaves the tap is $0.4 ms^{-1}$.

The diameter of the water stream at a distance $2 \times 10^{-1} m$ below the tap is close to:

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

B. (b) $9.6 \times 10^{-3} m$

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

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

Answer: C

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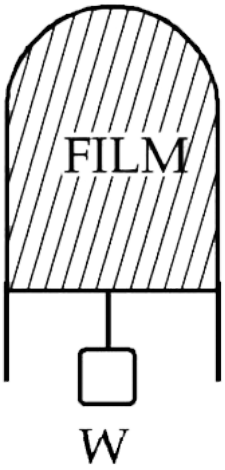
74. A thin liquid film formed between a U-shaped wire and a light slider supports a weight of $1.5 \times 10^{-2} N$ (see figure). The length of the slider is 30cm and its weight negligible. The surface tension of the liquid film is



A. (a) $0.0125 Nm^{-1}$

B. (b) $0.1Nm^{-1}$

C. (c) $0.05Nm^{-1}$

D. (d) $0.025Nm^{-1}$

Answer: D

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75. 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 σ at equilibrium position. The extension x_0 of the spring when it is in equlibrium is:

A. (a) $\frac{Mg}{k}$

B. (b) $\frac{Mg}{k}\left(1-\frac{LA\sigma}{M}\right)$

C. (c) $\frac{Mg}{k}\left(1-\frac{LA\sigma}{2M}\right)$

D. (d) $\frac{Mg}{k}\left(1+\frac{LA\sigma}{M}\right)$

Answer: C

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76. Assume that a drop of liquid evaporates by decreases 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. (a) $\rho L / T$

B. (b) $\sqrt{T / \rho L}$

C. (c) $T / \rho L$

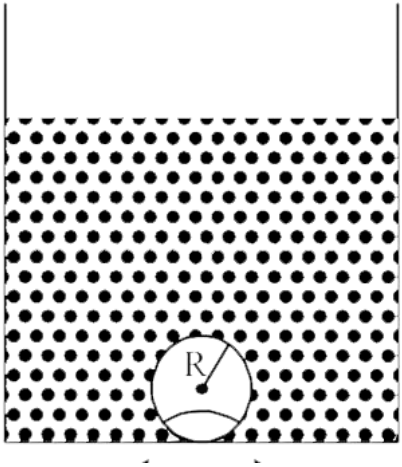
D. (d) $2T / \rho L$

Answer: D

Watch Video Solution

77. 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 $r << R$ and the surface tension of water is T, value of r just before bubbles detach is: (density of water is

ρ_w)



A. (a) $R^2\sqrt{\frac{\rho_w g}{3T}}$

B. (b) $R^2\sqrt{\frac{\rho_w g}{6T}}$

C. (c) $R^2\sqrt{\frac{\rho_w g}{T}}$

D. (d) $R^2\sqrt{\frac{3\rho_w g}{T}}$

Answer:

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78. An open glass tube is immersed in mercury in such a way that a lenth of 8cm 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 46cm. What will be length of the air column above mercury in the tube now?

(Atmosphere pressure =76cm of Hg)

A. (a) 16cm

B. (b) 22cm

C. (c) 38cm

D. (d) 6cm

Answer: B

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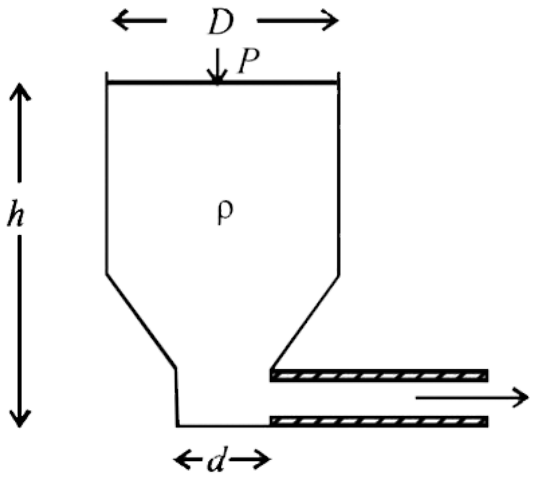
Subjective Problems

1. Shown in the figure is a container whose top and botoom diameters are D and d

respectively. At the bottom of the container, there is a capillary tube of outer radius b and inner radius a.

The volume flow rate in the capillary is Q. If the capillary is removed the liquid comes out with a velocity of v_0. The density of the liquid is given as ρ. Calculate the coefficient of viscosity η.



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