CPP-09
FS JEE(M) &
ADVANCED

Physics

Chapterwise Practise Problems (CPP) for JEE (Main & Advanced)

Chapter - Mechanical Properties of Fluids

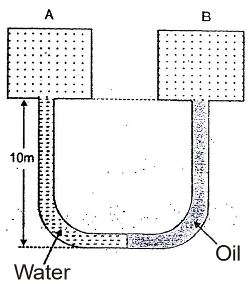
Level-1

SECTION - A

Straight Objective Type

This section contains multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

1. One side of vertical U-tube contains water and other contains oil as shown in figure. The ends of the tube are connected to the two vessels of same volume, Vessel A is filled with air at atmospheric pressure and vessel B is filled by some ideal gas. The absolute temperature inside vessel B is one fourth that of vessel A and number of moles inside vessel B is 5 times that of vessel A. The relative density of the oil is : (atmospheric pressure = 10^5 Pa, g = 10 m/s^2)



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

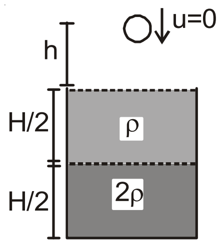
(C) $\frac{1}{2}$ (D) $\frac{1}{3}$

2. Assuming the xylem tissues through which water rises from root to the branches in a tree to be of uniform cross-section find the maximum radius of xylem tube in a 10 m high coconut tree so that water can rise to the top. (surface tension of water = 0.1 N/m. Density of water = 1000 kg/m^3. Angle of contact of water with xylem tube = 60° and g = 10 m/s^2)

(A) 1 cm (B) 1 mm

(C) 10^{-5} m (D) 10^{-6} m

3. A container contains two immiscicible liquids of densities ρ and 2ρ. A small ball of mass m is released from rest from a height h above the liquid surface. The density of ball is $\frac{\rho}{3}$: (assume no splash) (select correct alternative(s))



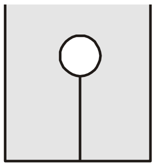
(A) If the minimum value of h is $\frac{3H}{2}$, then the ball will be able to enter the liquid of higher density

(B) If h ≥ $\frac{7H}{2}$, then the ball will be able to strike the bottom of the vessel

(C) If h = $\frac{7H}{2}$, then the ball will cross the interface of two liquids with kinetic energy = 2.5 mgH

(D) If the container is accelerated upwards and the ball is gently released on the surface of liquid, the fraction of submerged portion will be greater than $\frac{1}{3}$

4. A cork is suspended from the bottom of a container filled with water with a string as shown in figure. If the container accelerates in a horizontal direction towards right with acceleration a. Then select the correct option



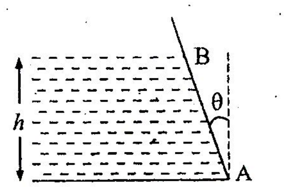
(A) Inclination of the string with vertical is $\tan^{-1}$ (a/g) towards left

(B) Inclination of the string with vertical is $\tan^{-1}$ (a/g) towards right

(C) Inclination of the string with vertical is $\pi/2 - \tan^{-1}$ (a/g) towards left

(D) Inclination of the string with vertical is $\pi/2 - \tan^{-1}$ (a/g) towards right.

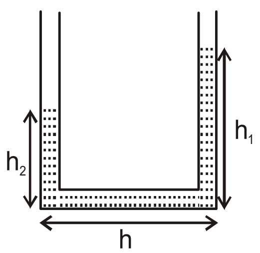
5. The height of water in a vessel is h. The vessel wall of width b is at an angle θ to the vertical. The net force exerted by the water on the wall is [Ignore atmospheric pressure]



(A) $\frac{1}{3}\rho p h^2 g$ (B) $\frac{1}{2} b h^2 \rho g$

(C) Zero (D) $\frac{1}{2}\rho h^2 b g \sec\theta$

6. The U-tube of uniform cross-section is filled with a liquid upto a height h_1 and h_2 in the two arms and then the liquid is allowed to move. When the level get equalized in the two arms, the liquid will be moving with velocity v =



(A) $(h_1 - h_2)\sqrt{\frac{g}{2(h_1 + h_2 + h)}}$

(B) $(h_1 - h_2)\sqrt{\frac{g}{2(h_1 + h_2)}}$

(C) $(h_1 - h_2)\sqrt{\frac{g}{2h}}$

(D) $(h_1 - h_2)\sqrt{gh}$

7. A soap bubble of radius, r and surface tension, T is given some charge spread uniformly over its surface. The relation between the new radius R and r in terms of excess pressure inside the bubble, P and T is (Assume V is final potential of the sphere)

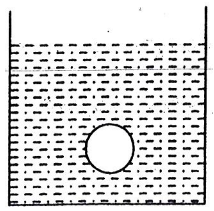
(A) $P = 4T(R^2 - r^2)$

(B) $P + \frac{1}{2}\frac{\varepsilon_0 V^2}{R^2} = \frac{4T}{R}$

(C) $P(R^3 - r^3) + 4T(R^2 - r^2) = \frac{1}{2}\varepsilon_0 V^2 R$

(D) $P + \frac{4T}{r} = \varepsilon_0 VR$

8. A smooth spherical ball of radius 1 cm and density 1×10^3 kg/m^3 is released from the bottom of the tank shown containing viscous liquid of density 2×10^3 kg/m^3, and η = 0.1 N-s/m^2. The distance moved by the ball in t = 0.1 sec after it attains terminal velocity is



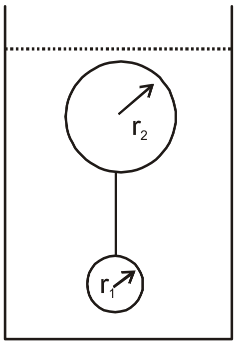
(A) 4/5 m upward

(B) 2/3 m downward

(C) 4/9 m downward

(D) 2/9 m upward

9. Two solid spherical balls of radius 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 greater density ρ with the string just taut as shown. Find the tension in the string when terminal velocity is attained



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

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

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

(D) $\frac{4}{3}\pi(\rho - \sigma)g r_1 r_2 (r_2 - r_1)$

10. A plastic circular disc of radius R is placed on a thin oil film, spread over a flat horizontal surface. The torque required to spin the disc about its central vertical axis with a constant angular velocity is proportional to

(A) R^2 (B) R^3

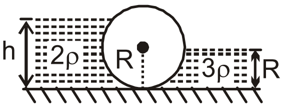
(C) R^4 (D) R^6

11. There is a uniform rectangular wire frame having, a thin film of soap solution. A massless thin wire in the form of a circular loop of radius R and area of cross section A is placed on the surface of film, and inside portion of the film is pricked. If surface tension of soap solution is S and Young's modulus of wire is Y then change in radius of the wire is :

(A) $\frac{SR^2}{AY}$ (B) $\frac{2SR^2}{AY}$

(C) $\frac{SR^2}{3AY}$ (D) $\frac{4SR^2}{AY}$

12. In the figure shown, the heavy cylinder (radius R) resting on a smooth surface separates two liquids of densities 2ρ and the 3ρ. The height h for the equilibrium of cylinder must be



(A) $\frac{3R}{2}$ (B) $R\sqrt{\frac{3}{2}}$

(C) $R\sqrt{2}$ (D) $R\sqrt{\frac{3}{4}}$

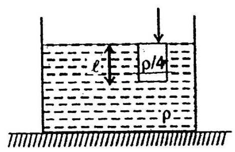
SECTION - C

Linked Comprehension Type

This section contains paragraph. Based upon this paragraph, 2 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE OR MORE** is/are correct.

Paragraph for Question Nos. 13 and 14

A large tank of cross-section area A contains liquid of density ρ. A cylinder of density $\rho/4$ and length ℓ, and cross-section area a (a << A) is kept in equilibrium by applying an external vertically downward force as shown. The cylinder is just submerged in liquid. At t = 0 the external force is removed instantaneously. Assume that water level in the tank remains constant.



13. The acceleration of cylinder immediately after the external force is removed is

(A) g (B) 2g

(C) 3g (D) zero

14. The speed of the cylinder when it reaches its equilibrium position is:

(A) $\frac{1}{2}\sqrt{g\ell}$ (B) $\frac{3}{2}\sqrt{g\ell}$

(C) $\sqrt{2g\ell}$ (D) $2\sqrt{g\ell}$

Paragraph for Question Nos. 15 and 16

Many species of (animals mostly insects and spiders) are capable of walking on the surface of water. Compared to the displacement required to float only a very small part of the water walking animal's body is below the ambient water surface level. The animal's weight is mostly carried by surface tension while buoyancy is negligible.

The water is deformed by animal's weight and makes contact with its feet along a combined perimeter length L (Total length in contact with surface). Here we define a parameter 'Bond number' B_0. Bond number is the ratio of weight and surface tension force. If B_0 is less than 1 then the animal floats, if it is more than 1 then it drowns.

15. An insect with mass 10 mg and total length of the contact perimeter 1.3 mm can just walk on the liquid surface. The surface tension of liquid is:

(A) 0.058 N/m (B) 0.026 N/m

(C) 0.076 N/m (D) 0.112 N/m

16. Mass of insect A is 15 mg and total contact perimeter is 2.5 mm. Mass of insect B is 6 mg and total contact perimeter is 0.6 mm. The surface tension of a liquid is 7.5×10^{-2} N/m. Both insect are on surface of the liquid.

(A) insect A will float while insect B will drown

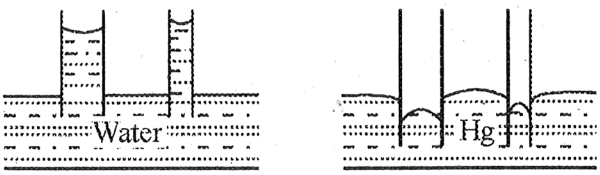
(B) insect B will float while insect A will drown

(C) both insects will float

(D) both insects will drown

Paragraph for Question Nos. 17 to 19

When a glass capillary tube open at both ends is dipped vertically in water, the water rises up in the tube to a certain height above the water level outside the tube. The narrower the tube, the higher is the rise of water. On the other hand, if the tube is dipped in mercury the mercury is depressed below the outside level. The phenomenon of rise or depression of liquids in a capillary tube is called capillarity. The rise or fall of liquid in a capillary is given by $h = \dfrac{2T\cos\theta}{dg}$



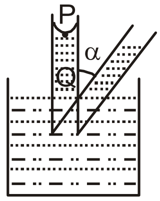
where r is the radius of capillary tube, d is density of liquid and θ is the angle of contact

17. By inserting a capillary tube upto depth l in water, the water rises to a height h. If the lower end of the capillary is closed inside water and the capillary is taken out and closed end opened, to what height water will remain in the tube? l > h

(A) Zero (B) l + h

(C) 2h (D) h

18. Water rises in a straight capillary tube upto a height of h cm when held vertically in water. If the tube is inclined as shown in figure, the vertical height of water column in it will be



(A) h (B) Less than h

(C) More than h (D) h cos α

19. The radius of curvature of the meniscus of liquid rising in the tube is

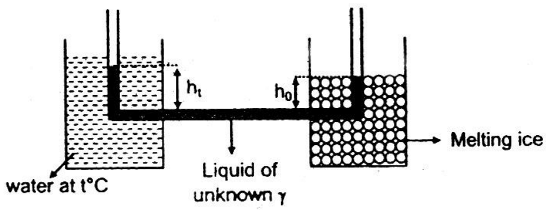
(A) r sin θ (B) r/sin θ

(C) r cos θ (D) r/cos θ

Paragraph for Questions 20 and 21

When the expansion of a liquid in a vessel is measured to obtain the coefficient of volume expansion (g), what is actually obtained is apparent coefficient of expansion. This is due to expansion of container. The figure shown is an apparatus to find out correct coefficient of expansion without knowing coefficient of expansion of the container.

It consists of a U-shaped tube with long base and two limbs. Its two limbs are kept at 0°C and t°C with the help of melting ice and water at t°C. A liquid of unknown γ is taken in U-tube. For the given steady state there is no flow of liquid from one limb to other. Height of the liquid in two columns is h_0 and h_1 respectively



20. The coefficient of volume expansion of liquid (γ) in the tube can be expressed as

(A) $\dfrac{h_0}{(h_t - h_0)}$ (B) $\dfrac{(h_t - h_0)}{(h_0 t)}$

(C) $\dfrac{h_t}{h_0 t}$ (D) $\dfrac{h_0}{h_t t}$

21. For a liquid at t=20°C h_0 and h_t are measured to be 100 cm and 101 cm respectively. In this same liquid in a vessel a solid cylinder is floating. If on increasing temperature of the system depth of submergence of cylinder is unchanged thermal coefficient of linear expansion of the cylinder is

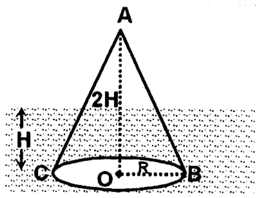
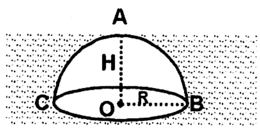
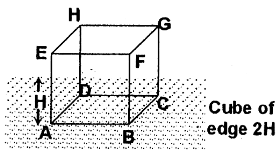
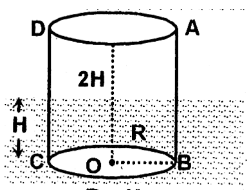
(A) 5×10^{-4} per °C (B) 1.67×10^{-4} per °C

(C) 2.5×10^{-4} per °C (D) 10^{-3} per °C

SECTION-D
Matrix-Match Type

This **Section D** have "match the following" type question. Question contains two columns, **Col-I** and **Col-II**. Match the entries in **Col-I** with the entries in **Col-II**. One or more entries in **Col-I** may match with one or more entries in **Col-II**.

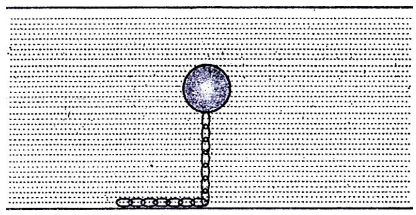
22. A solid cone, a solid hemisphere, a solid cube and a solid cylinder of different material float in an ideal liquid of density ρ_0. F is the pressure force due to liquid acting on the body except on the base inside the liquid, F_b is the net force of buoyancy acting on the body and ρ is density of the body. [Neglect the effect of air pressure] Match column I and column II

Column I	**Column II**
(A) F_b is maximum	(p)  R = H
(B) F is maximum	(q)  R = H
(C) F is minimum	(r) 
(D) ρ is maximum	(s)  R = H

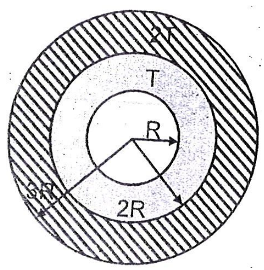
SECTION-E
Integer Answer Type

This section contains Integer type questions. The answer to each of the questions is an integer.

23. One end of an iron chain is fixed to a sphere of mass M = 10 kg (the volume of such a sphere is V = $0.0141 m^3$), while the other end is free. The length 'l' of the chain is 3 metre and its mass 'm' is 9 kg. The sphere with the chain is in a water reservoir (see fig.). The length of floating part of chain is approximately $\frac{\pi}{\eta}$ meter. Find η [ρ_{water} = 1000 kg/m^3, ρ_{iron} = 7850 kg/m^3)

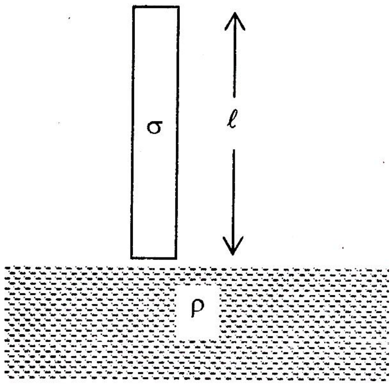


24. Three concentric wires of radii R, 2R and 3R contain two differential liquid films of surface tension T and 2T as indicated in the figure. The outermost and the innermost wires are fixed. Neglecting the effect of gravity, the tension in the middle wire is $\frac{XTR}{2}$, then x is



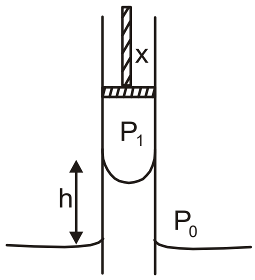
25. A uniform vertical cylinder is released from rest when its lower end just touches the liquid surface of a deep lake. Calculate maximum displacement of of cylinder (in meter)

Take, $\ell = 4$m and $\frac{\sigma}{\rho} = \frac{1}{2}$



26. A cube floating in a liquid (immiscible with water) contained in a beaker has one-third of its volume submerged in that liquid. Water is poured into the beaker till the cube is completely covered. What fraction of the volume of the cube is now submerged in that liquid ? If the fraction is $\frac{1}{x}$, find x. The relative density of the liquid = 9

27. A capillary of radius r = 0.2 mm is dipped vertically inside water of density $\rho = 10^3$ kg/m^3. A small piston (x) is inserted inside the capillary which maintains constant pressure $P_1 = 0.5 \times 10^5$ N/m^2 in the air above hemispherical meniscus. Atmospheric pressure $P_0 = 10^5$ N/m^2 and surface tension of water T = 10 N/m. If the height of the water in capillary tube is found to be h = 5x meter, find the value of x.



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SECTION - A

Straight Objective Type

This section contains multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

1. A thin and light thread of sufficient length L is attached to a wire frame. The frame (along with the thread) is dipped into soap solution. When the frame is taken out of the solution, the thread takes the form of a semicircle with a soap film extending between the frame and the thread as shown in the figure (a). Now the thread is deformed into two semicircles by applying a force of F at the middle of the thread, as a result the film gets stretched as shown in the figure (b). Calculate the surface tension of the soap solution.

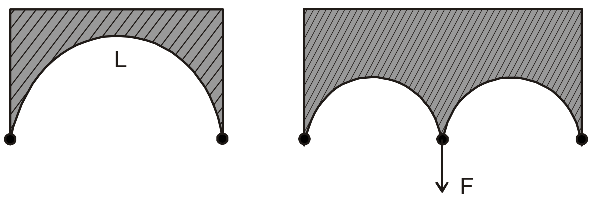


fig. (a) fig. (b)

(A) $\frac{\pi F}{2L}$ (B) $\frac{\pi F}{L}$

(C) $\frac{2\pi F}{L}$ (D) $\frac{1}{4}\frac{\pi F}{L}$

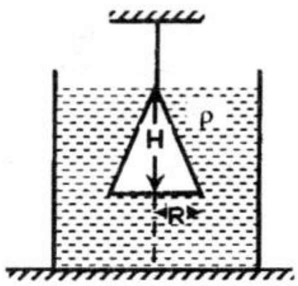
2. A cone of radius R and height H, is hanging inside a liquid of density ρ by means of a string as shown in the figure. The force due to the liquid acting on the slant surface of the cone is

(A) $\rho\pi gHR^2$

(B) $\pi\rho HR^2$

(C) $\frac{4}{3}\pi\rho gHR^2$

(D) $\frac{2}{3}\pi\rho gHR^2$

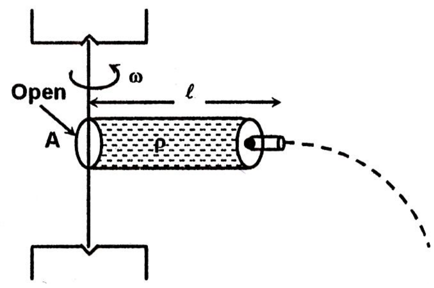


3. Two capillary tubes of diameters 3.0 mm and 6.0 mm are joined together to form a U-tube open at both ends. If the U-tube is filled with water, what is the approximate difference in its levels in the two limbs of the tube ? Surface tension of water at the temperature of the experiment is 7.3×10^{-2} N/m. Take the angle of contact to be zero and density of water to be 10^3 kg/m^3 (g = 9.8 m/s^2)

(A) 5 mm (B) 10 mm

(C) 15 mm (D) 20 mm

4. A pipe is rotating with a constant angular velocity ω in a horizontal plane at a height of h from the ground and completely filled with liquid of density ρ as shown in the figure. One end of pipe is open and its cross sectional area is A. At t = 0 a hole of cross sectional area a (a<<A) is created on the other end. Find the magnitude of flow veloicty just outside the hole with respect to ground at t = 0. (Take atmospheric pressure P_0)



(A) $2\omega\ell$

(B) $\sqrt{2}\omega\ell$

(C) $\omega\ell$

(D) $\omega\ell/2$

5. The speed of flow at the lower surface of a wing of an air plane is 50 m/s. What speed of flow at the upper surface will give it a lift of 980 N/m^2? (Density of air is 1.2 kg/m^3)

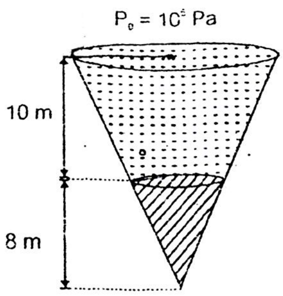
(A) 64.3 m/s

(B) 32.2 m/s

(C) 16.1 m/s

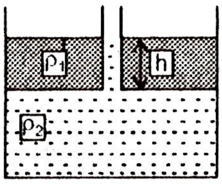
(D) None of these

6. The figure shows a conical container of half-apex angle 37° filled with certain amount of kerosene and water as shown. Specific gravity of kerosene is 0.8 and axis of cone is vertical. The force exerted by the water on the kerosene is approximately (Take atmospheric pressure = 10^5 Pa and g = 10m/s^2)



(A) 3×10^6 N (B) 4×10^7 N
(C) 2×10^7 N (D) 5×10^7

7. A container contains two immiscible liquids of density ρ_1 and ρ_2 ($\rho_2 > \rho_1$). A capillary of radius r is inserted in the liquid so that its bottom reaches upto denser liquid and lighter liquid does not enter the capillary. Denser liquid rises in capillary and attain height equal to h which is also equal to column length of lighter liquid. Assuming zero contact angle find surface tension of heavier liquid



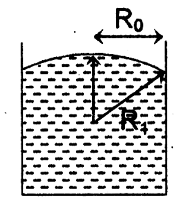
(A) $\frac{r\rho_2 gh}{2}$

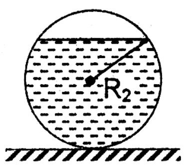
(B) $2\pi r\rho_2 gh$

(C) $\frac{r}{2}(\rho_2 - \rho_1)gh$

(D) $2\pi r(\rho_2 - \rho_1)gh$

8. A liquid is placed in a cylindrical glass container of radius R_0. In gravity free space, free surface of liquid has spherical shape of radius of curvature R_1. Now same liquid is placed in a large spherical glass container of radius R_2 in uniform gravity. If surface of liquid in spherical container is found to be flat, then find the height of liquid surface in spherical container from centre of container





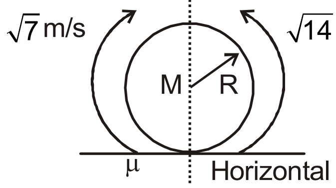
(A) $\sqrt{\frac{R_1 R_2}{R_0}}$

(B) $\frac{R_1 R_2}{R_0}$

(C) $R_0 \frac{R_1}{R_2}$

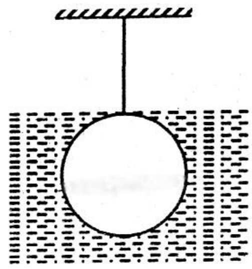
(D) $R_0 \frac{R_2}{R_1}$

9. A solid sphere of mass M and radius R is kept on a rough surface. The velocities of air (density ρ) around the sphere are as shown in figure. Assuming R to be small and $M = \frac{4\pi\rho R^2}{g}$kg, what is the minimum value of coefficient of friction so that the sphere starts pure rolling? (Assume force due to pressure difference is acting on centre of mass of the sphere)



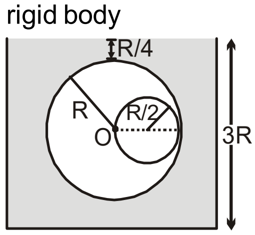
(A) 0.25
(B) 0.50
(C) 0.75
(D) 1.0

10. A sphere of radius R and relative density 4 is hanging with the help of a string such that it remains just inside water. The ratio of force exerted by the liquid on upper and lower half of the sphere is (Neglect atmospheric pressure).



(A) 1 : 5 (B) 1 : 4
(C) 2 : 5 (D) 1 : 3

11. A uniform solid sphere of density $8\rho/7$ and radius R has a spherical cavity of radius R/2 between the centre and surface of the sphere. It is immersed in a tank containing liquid of density ρ with the liquid level R/4 above the sphere top. The sphere is released from rest at the position shown with centre of cavity and the centre if the sphere at the same horizontal level. Take moment of inertia of the sphere about an axis through centre of mass of the rigid body and normal to the page as kmR^2, where m is mass of the rigid body



The initial acceleration of the centre O of the sphere is nearly

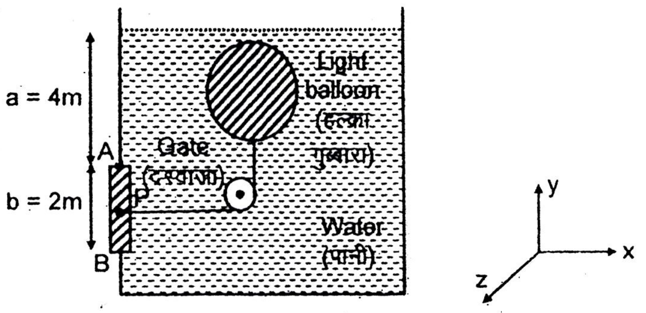
(A) g/196k (B) g/7k
(C) 3kg/14 (D) 3 kg/196

SECTION - B

Multiple Correct Answer Type

This section contains multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONE OR MORE** is/are correct.

12. The figure here shows a water tank provided with a square gate (of side 2m) which can be rotated freely about z axis passing through shown point A. The gate is held in its place due to buoyant force acting on the light balloon attached to the gate via a light thread. Considering the information that the gate just opens when level of water reaches the height of 4m about point A and hinge force is zero, the shown point P is point at which the thread is attached to the gate



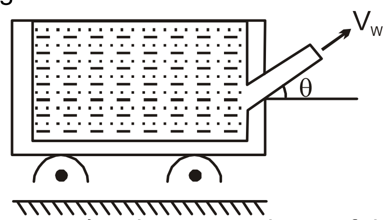
(A) Volume of water displaced by the balloon is 20 m^3

(B) Volume of water displaced by balloon is 30 m^3

(C) Distance between A and P is approximately 1.06 m

(D) Force on gate due to water is 15 kN

13. Consider a cart of mass M on a frictionless surface that can hold a full tank of water with mass M. A fire-hose sprays water with a constant ejection speed V_w at a constant mass rate $r = \frac{dm}{dt}$ and at an angle θ relative to the horizontal



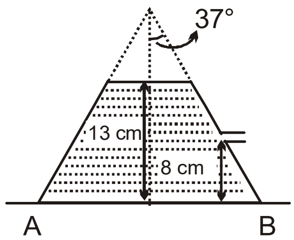
(A) The acceleration at any time t of the cart while it is spraying water is given by $\frac{V_w r\cos\theta}{M-rt}$

(B) The speed of the cart as a function of time $\left(t < \frac{M}{r}\right)$ is $\frac{V_w rt\cos\theta}{M-rt}$

(C) The speed of the cart as a function of time $\left(t < \frac{M}{r}\right)$ is $V_w \cos\theta \ln(M-rt)$

(D) The external horizontal force that must be applied to keep the cart stationary while spraying water is $rV_w\cos\theta$

14. Curved surface of a vessel with negligible mass has shape of a truncated cone having semi vertex angle 37°. Vessel is full of water (density ρ = 1000 kg/m^3) upto to height of 13 cm and is placed on a smooth horizontal plane. Upper surface is opened to atmosphere. A hole of 1.5 cm^2 is made on curved wall at a height of 8 cm from bottom which is fitted to a light horizontal pipe as shown in figure. Area of water surface in the vessel is large as compared to the area of hole



(A) Initial velocity of efflux is 1 m/sec

(B) Initial horizontal range of water jet with respect to point B of the cone. is 6.65 cm

(C) Horizontal force required to keep the vessel in static equilibrium is 0.15 N

(D) Horizontal force required to keep the vessel in static equilibrium is 0.12 N

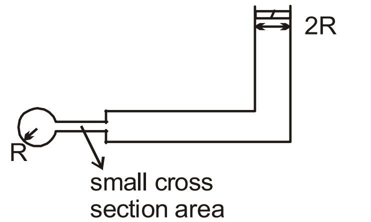
SECTION - C

Linked Comprehension Type

This section contains paragraph. Based upon this paragraph, 2 multiple choice questions have to be answered. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE OR MORE** is/ are correct.

Paragraph for Question Nos. 15 and 16

Soap bubble of radius R is blown at end of pipe of circular cross-section of radius R as shown in diagram. On the vertical portion of pipe, there is a piston of mass m. T is surface tension of liquid of soap bubble.



15. Find the mass of piston for which it remain in equilibrium :

(A) $\frac{4\pi TR}{g}$ (B) $\frac{2\pi TR}{g}$

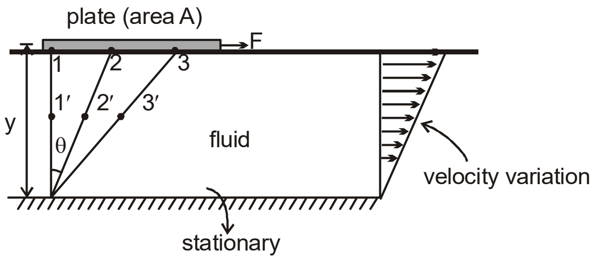
(C) $\frac{4TR}{g}$ (D) $\frac{4TR^2}{g}$

16. If piston is slightly displaced in downward direction, then its acceleration when radius of bubble grows to 2R is

(A) 2g (B) g/2
(C) 3g/2 (D) g/4

Paragraph for Question Nos. 17 and 18

Viscosity is the property of fluid by virtue of which fluid offers resistance to deformation under the influence of a tangential force

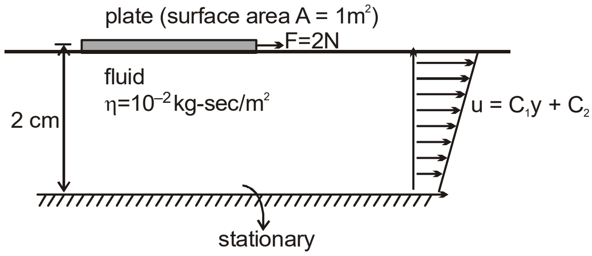


In the given figure as the plate moves the fluid particle at the surface moves from position 1 to 2 and so on, but particles at the bottom boundary remains stationary. If the gap between plate and bottom boundary is small, fluid particles in between plate and bottom moves with velocities as shown by linear velocity distribution curve otherwise the velocity distribution may be parabolic. As per Newton's law of viscosity the tangential force is proportional to shear strain rate.

$\frac{F}{A} \alpha \frac{d\theta}{dt}$ but $y\frac{d\theta}{dt} = u$, $\frac{d\theta}{dt} = \frac{u}{y}$ then F = $\eta A\frac{u}{y}$, η = coefficient of viscosity for non-linear velocity distribution

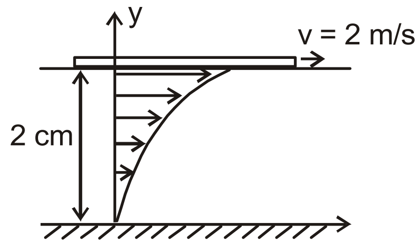
F = $\eta A\frac{du}{dy}$ where $\frac{u}{y}$ or $\frac{du}{dy}$ is known as velocity gradient

17. Velocity distribution is given by $u = C_1y + C_2$ as shown in the figure. Force of 2N is required to maintain constant velocity 'v' of plate. Area of plate is $1m^2$. Select correct values of variables in SI unit.



(A) C_1 = 200 (B) C_1 = 100
(C) v = 4 (D) v = 2

18. If velocity distribution is given as (parabolic)
$u = C_1y^2 + C_2y + C_3$

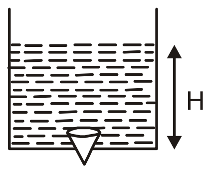


Force of 2N is required to maintain constant velocity 2 m/sec of the same plate,then in SI unit -

(A) C_1 = 5000 (B) C_2 = 0
(C) C_3 = 0 (D) C_2 = 2

Paragraph for Question Nos. 19 to 21

Read the paragraph carefully and answer the following questions :



A tank has a hole of area 2 cm^2 at its bottom and in this hole a conical cork is placed and water is filled up. The water level is made to fall slowly by means of another orifice in the tank. When the water level comes to a height of 'H' cm, the conical cork just comes out from the hole. Given, volume of water displaced by the cork = 80 cm^3, mass of the cork = 40 gm, density of water = 1 gm/cm^3. Area of circular cross-section of conical cork = 8cm^2, Height of cork submerged in water = $\frac{120}{7}$ cm. Take g = 10 m/s^2, $\pi = \frac{22}{7}$ and $P_0 = 10^5$ N/m^2

19. Calculate the value of H

(A) 15cm (B) 20 cm
(C) 22 cm (D) 17 cm

20. Calculate the force exerted by water on the curved surface of the conical cork submerged in water when the liquid level in the vessel is equal to H

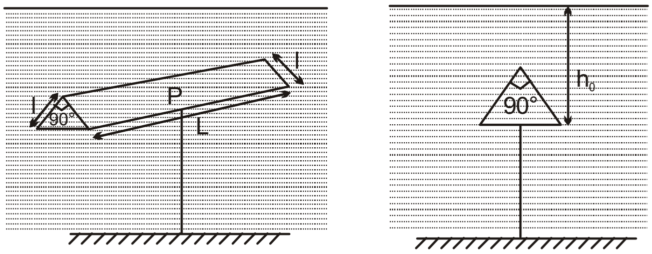
(A) 1.3N (B) 60.63N
(C) 0.63N (D) 70.63N

21. The total force exerted by all the fluids on the conical cork in the vertical direction is (when liquid level is H)

(A) 0.4N (B) 0.8N
(C) 1N (D) 1.4N

Paragraph for Question Nos. 22 to 24

A prism shaped styrofoam of density $\rho_{styrofoam}$ ($<\rho_{water}$) is held completely submerged in water. It lies with its base horizontal. The base of foam is at a depth h_0 below water surface and atmospheric pressure is P_0. Surface of water is open to atmosphere. Styrofoam prism is held in equilibrium by the string attached symmetrically as shown (Take: $\rho_{styrofoam} = \rho_f$; $\rho_{water} = \rho_w$)



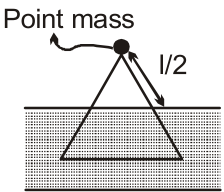
22. Net force exerted by liquid on the styrofoam is

(A) $\sqrt{2}\rho_w g l^2 L$ (B) $2\rho_w g l^2 L$
(C) $\rho_w g \frac{l^2 L}{2}$ (D) $\rho_w g l^2 L$

23. Magnitude of force exerted by water on any one of the slant face of styrofoam is

(A) $(P_0 + \rho_w g(h_0 - \sqrt{2}l))Ll$ (B) $\left(P_0 + \rho_w g\left(h_0 - \frac{l}{\sqrt{2}}\right)\right)Ll$
(C) $\left(P_0 - \rho_w g\left(h_0 - \frac{l}{\sqrt{2}}\right)\right)Ll$ (D) $\left(P_0 + \rho_w g\left(h_0 - \frac{l}{2\sqrt{2}}\right)\right)Ll$

24. Now string is cut and styrofoam is allowed to come to surface. A point mass is to be placed at the midpoint of the upper edge of styrofoam such that it is in equilibrium with its base horizontal. In equilibrium position styrofoam has half of its slant length submerged. Surface tension of water is T, contact angle is 0°. Determine mass m to achieve equilibrium



(A) $\frac{\rho_f g L l^2}{2} + \frac{3}{4}\rho_w g L l^2 - 2T[L+l]$

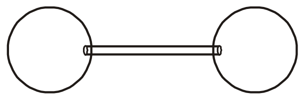
(B) $\frac{-\rho_f L l^2}{2} + \frac{3}{8}\rho_w L l^2 - \frac{\sqrt{2}T[L+l]}{g}$

(C) $\frac{-\rho_f g L l^2}{2} + \frac{3}{8}\rho_w g L l^2 - \frac{T[L+l]}{\sqrt{2}}$

(D) None of these

Paragraph for Questions 25 and 26

Two spherical soap bubbles in vaccum are connected through a narrow tube. Radius of left bubble is R and that of other is slightly smaller than R. Air flows from right to left very slowly. At any instant r_1, A_1, V_1, n_1 are radius, surface area, volume and number of moles of gas in the left bubble and r_2, A_2, V_2, n_2 are same for right bubble. Assume that temperature remains constant :



25. For which of the followings the rate of change with respect to time is zero
(A) $r_1 + r_2$ (B) $A_1 + A_2$ (C) $V_1 + V_2$ (D) $n_1 + n_2$

26. Suppose at any instant number of moles in left bubble is 4 times of number of moles in right bubble then :

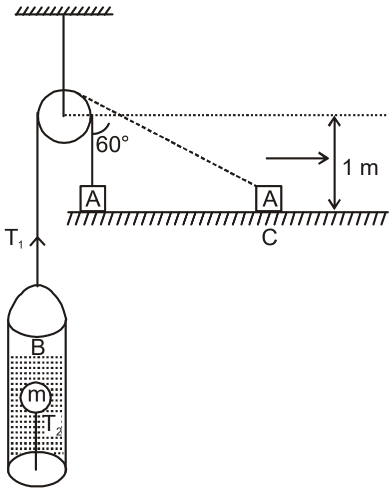
(A) $r_2 = R\sqrt{\frac{2}{5}}$ (B) $r_1 = R\sqrt{\frac{8}{5}}$
(C) $r_1 = \frac{R}{3}$ (D) $r_2 = \frac{2R}{3}$

SECTION-E

Integer Answer Type

This section contains Integer type questions. The answer to each of the questions is an integer.

27. Cylindrical bucket (B) with water in it has total mass 10 kg and balances of mass of 12 kg (A) on horizontal surface as shown in the figure. A piece of cork of mass m = 2 kg and specific gravity 0.5 is tied to the bottom of the bucket through a light string. A is moved horizontally with constant velocity 4 m/s as shown. Find the ratio of tension T_1 and T_2 at the instant A reaches point c where T_1 is the tension in string connected to bucket and T_2 is tension in string connected to cork.



28. A thin spherical soap bubble has surface tension S. It's surface is charged with charge Q, its volume is V. It is found that when $Q^2 = n\pi\varepsilon_0 SV$, the excess pressure inside the bubble becomes zero. Find n/12

❑ ❑ ❑

ANSWERS

LEVEL-1

1. (B)	2. (D)	3. (B.C)	4. (B)	5. (D)	6. (A)
7. (B)	8. (D)	9. (D)	10. (C)	11. (B)	12. (B)
13. (C)	14. (B)	15. (C)	16. (A)	17. (C)	18. (A)
19. (D)	20. (B)	21. (C)	22. (A-r B-p ,C-r,s, D-q)		23. (2)
24. (8)	25. (4)	26. (4)	27. (3)		

LEVEL-2

1. (A)	2. (D)	3. (A)	4. (B)	5. (A)	6. (C)
7. (C)	8. (D)	9. (A)	10. (A)	11. (A)	12. (A,C)
13. (A,D)	14. (A,C)	15. (A)	16. (B)	17. (A,C)	18. (A,B,C)
19. (B)	20. (B)	21. (A)	22. (C)	23. (D)	24. (B)
25.(B)	26. (A,B)	27. (6)	28. (8)		

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