Resonance
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TARGET : JEE (ADVANCED) 2015

Course : VIJETA & VIJAY (ADP & ADR) **Date : 28-04-2015**

PHYSICS
DPP
DAILY PRACTICE PROBLEMS

NO. 07

TEST INFORMATION

DATE : 29.04.2015 **PART TEST(PT) - 03 (3 hours)**

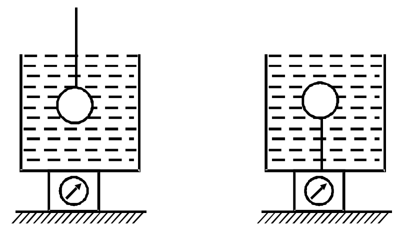
Syllabus : Electromagnetic induction, Alternating current, wave optics, Rigid body dynamics, Simple harmonic motion, Properties of matter complete

This DPP is to be discussed (01-05-2015)
PT-3 to be discussed (01-05-2015)

DPP No. # 07

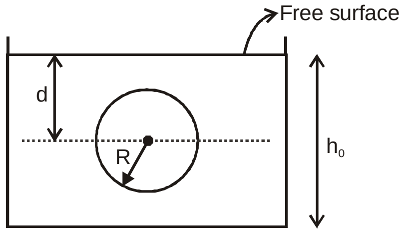
Total Total Marks : 150	**Max. Time : 117 min.**	
Single choice Objective (–1 negative marking) Q. 1 to 15	**(3 marks 2½ min.)**	**[45, 37½]**
Multiple choice objective (–1 negative marking) Q. 16 to 21	**(4 marks, 3 min.)**	**[24, 18]**
Single Digit Subjective Questions (no negative marking) Q.22 to Q.30	**(4 marks 2½ min.)**	**[36, 22½]**
Comprehension (–1 negative marking) Q.31 to 42	**(3 marks 2½ min.)**	**[36, 30]**
Match Listing (–1 negative marking) Q.43 to Q.45	**(3 marks, 3 min.)**	**[9, 9]**

1. A container open from top, filled with water (density ρ_w) upto the top, is placed on a weighing machine and the reading is W. A wooden ball of volume V and mass m is put in the water by the given two arrangements. In arrangement–1, the ball is connected by a rigid rod (of negligible volume) and pushed in the water. In arrangement–2, the ball is attached with bottom by a massless string. The reading of weighing machine, (density of wood is less than water) (choose incorrect option) :



(A) In arrangement–1 is W
(B) In arrangement–1 is W + ρVg
(C) In arrangement–2 is W + mg – ρ_wVg
(D) In arrangement–2 is less that in arrangement–1

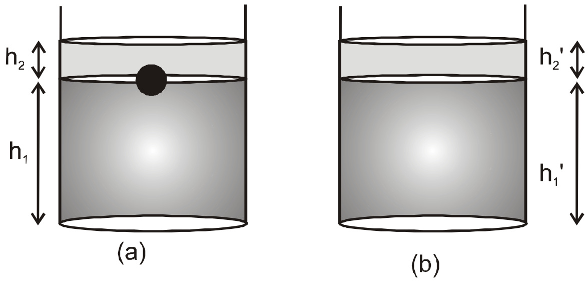
2. A uniform solid sphere of radius R is in equilibrium inside a liquid whose density varies with depth from free surface as $\rho = \rho_0\left(1+\frac{h}{h_0}\right)$, where h is depth from free surface. Density of sphere σ will be :



(A) $\sigma = \rho_0\left(1+\frac{d}{2h_0}\right)$ (B) $\sigma = \rho_0\left(1-\frac{d}{2h_0}\right)$

(C) $\sigma = \rho_0\left(1+\frac{2d}{h_0}\right)$ (D) $\sigma = \rho_0\left(1+\frac{d}{h_0}\right)$

3. A piece of Ice floats in a vessel with water above which a layer of lighter oil is poured. When ice melts :



1. The level of oil water interface falls
2. The level of oil water interface rises
3. The thickness of oil layer decreases
4. The thickness of oil layer remain same
5. The thickness of oil layer increases
6. The level of oil-air interface falls
7. The level of oil-air interface remains same
8. The level of oil-air interface rises

Select the correct alternatives :

(A) only 4 & 7 are correct (B) 2, 3 & 6 are correct

(C) 1 , 5 & 7 are correct (D) Only 8 is correct

4. A large open tank is filled with water upto a height H. A small hole is made at the base of the tank. It takes T_1 time to decrease the height of water to $\frac{H}{n}$ (n > 1) and it takes T_2 time to take out the remaining water. If $T_1 = T_2$, then the value of n is :

(A) 2 (B) 3 (C) 4 (D) $2\sqrt{2}$

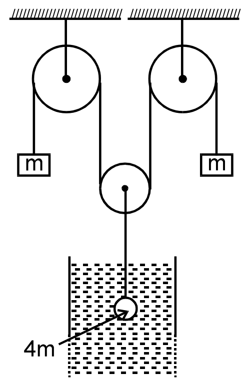
5. A capillary tube with inner cross-section in the form of a square of side *a* is dipped vertically in a liquid of density ρ and surface tension σ which wet the surface of capillary tube with angle of contact θ. The approximate height to which liquid will be raised in the tube is : (Neglect the effect of surface tension at the corners of capillary tube)

(A) $\frac{2\sigma\cos\theta}{a\rho g}$ (B) $\frac{4\sigma\cos\theta}{a\rho g}$ (C) $\frac{8\sigma\cos\theta}{a\rho g}$ (D) None of these

6. A sphere of mass m and radius r is projected in a gravity free space with speed v. If coefficient of viscosity is $\frac{1}{6\pi}$, the distance travelled by the body before it stops is :

(A) $\frac{mv}{2r}$ (B) $\frac{2mv}{r}$ (C) $\frac{mv}{r}$ (D) none of these

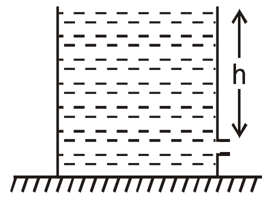
7. A spherical ball of mass 4m, density σ and radius r is attached to a pulley-mass system as shown in figure. The ball is released in a liquid of coefficient of viscosity η and density ρ ($<\frac{\sigma}{2}$). If the length of the liquid column is sufficiently long, the terminal velocity attained by the ball is given by (assume all pulleys to be massless and string as massless and inextensible) :



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

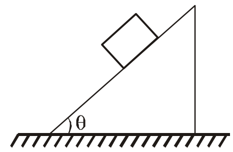
(C) $\frac{2}{9}\frac{r^2(\sigma-4\rho)g}{\eta}$ (D) $\frac{1}{9}\frac{r^2(\sigma-2\rho)g}{\eta}$

8. In the figure shown, a light container is kept on a horizontal rough surface of coefficient of friction $\mu = \frac{Sh}{V}$. A very small hole of area S is made at depth 'h'. Water of volume 'V' is filled in the container. The friction is not sufficient to keep the container at rest. The acceleration of the container initially is



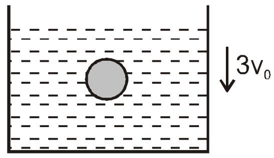
(A) $\frac{V}{Sh}g$ (B) g (C) zero (D) $\frac{Sh}{V}g$

9. A cubical block of side 'a' and density 'ρ' slides over a fixed inclined plane with constant velocity 'v'. There is a thin film of viscous fluid of thickness 't' between the plane and the block. Then the coefficient of viscosity of the thin film will be : (Acceleration due to gravity is g)



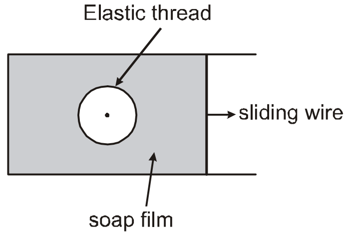
(A) $\eta = \frac{\rho\, agt \sin\theta}{v}$ (B) $\frac{\rho\, agt^2 \sin\theta}{v}$ (C) $\frac{v}{\rho\, agt \sin\theta}$ (D) none of these

10. A container filled with viscous liquid is moving vertically downwards with constant speed $3v_0$. At the instant shown, a sphere of radius r is moving vertically downwards (in liquid) has speed v_0. The coefficient of viscosity is η. There is no relative motion between the liquid and the container. Then at the shown instant, the magnitude of viscous force acting on sphere is



(A) $6\pi\eta r v_0$ (B) $12\pi\eta r v_0$
(C) $18\pi\eta r v_0$ (D) $24\pi\eta r v_0$

11. The figure shows a soap film in which a closed elastic thread is lying. The film inside the thread is pricked. Now the sliding wire is moved out so that the surface area increases. The radius of the circle formed by elastic thread will

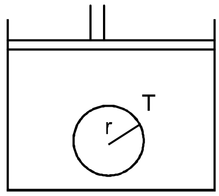


(A) increase (B) decrease (C) remain same (D) data insufficient

12. An isolated and charged spherical soap bubble has a radius 'r' and the pressure inside is atmospheric. If 'T' is the surface tension of soap solution, then charge on drop is:

(A) $2\sqrt{\frac{2rT}{\varepsilon_0}}$ (B) $8\pi r\sqrt{2rT\,\varepsilon_0}$ (C) $8\pi r\sqrt{rT\,\varepsilon_0}$ (D) $8\pi r\sqrt{\frac{2rT}{\varepsilon_0}}$

13. In a cylinder-piston arrangement, air is under a pressure P_1. A soap bubble of radius r lies inside the cylinder,soap bubble has surface tension T. The radius of soap bubble is to be reduced to half, The new pressure P_2 to which air should be compressed isothermally. (Assume r is very small as compared to height of cylinder)

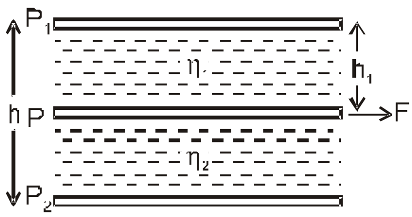


(A) $P_1 + \dfrac{4T}{r}$ (B) $4P_1 + \dfrac{12T}{r}$

(C) $8P_1 + \dfrac{24T}{r}$ (D) $P_1 + \dfrac{2T}{r}$

14. The radius of soap bubble is R and surface tension of soap solution is T, keeping the temperature constant, the extra energy needed to double the radius of the soap bubble by blowing will be :
(A) $32\pi R^2T$ (B) $24\pi R^2T$ (C) $16\pi R^2T$ (D) $8\pi R^2T$

15. A thin horizontal movable plate P is separated from two fixed horizontal plates P_1 and P_2 by two highly viscous liquids of coefficient of viscosity η_1 and η_2 as shown, where $\eta_2 = 4\eta_1$. Area of contact of movable plate with each fluid is same. If the distance between two fixed plates is h, then the distance h_1 of movable plate from upper fixed plate such that the movable plate can be moved with a constant velocity by applying a minimum constant horizontal force F on movable plate is (assume velocity gradient to be uniform in each liquid).



(A) $\dfrac{h}{4}$ (B) $\dfrac{h}{2}$ (C) $\dfrac{2h}{3}$ (D) $\dfrac{h}{3}$

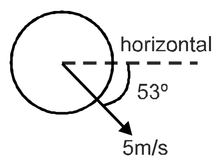
16. A container of large uniform cross sectional area A resting on a horizontal surface holds two immiscible non-viscous and incompressible liquids of density d and 3d each of height H/2. The lower density liquid is open to the atmosphere having pressure P_o. A tiny hole of area a (a<<A) is punched on the vertical side of the lower container at a height h (0 < h < H/2) for which range is maximum.

(A) h = H/3 (B) Range $R = \dfrac{2H}{3}$

(C) Range $R = \dfrac{3H}{2}$ (D) velocity of efflux r $v = \sqrt{\dfrac{2}{3}gH}$

17. In a certain gravity free space, the piston of an injection is being pushed so that the water jet comes out with a speed v. The area of the piston is much greater than the orifice of the injection.
(A) The force required to be applied on the piston is proportional to v^2.
(B) The power developed by the force pushing the piston is proportional to v^3.
(C) The time for emptying the injection is proportional to v^{-1}.
(D) The total work done in emptying the injection is proportional to v^2.

18. An external force 6N is applied on a sphere of radius R = 10 cm of mass 1 kg and the sphere moves in a liquid with a constant velocity 5 m/s making 53^0 with the horizontal.The coefficient of viscosity of the liquid is $20/(6\pi)$, in S.I. units. (Take g = 10 m/s^2)



(A) The viscous force on the body is 10N.
(B) The effective weight (weight – upthrust) of the body is 8 N
(C) The direction of the external applied force must be horizontal.
(D) If the external force is suddenly removed the acceleration of the body just after the removal of the force will be 6 m/s^2.

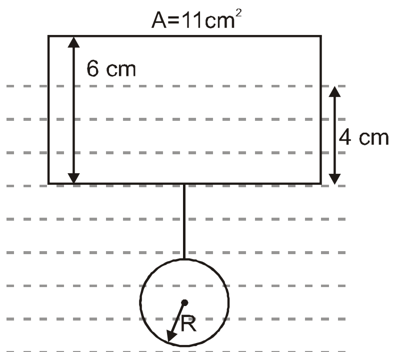
19. A block of density 2000 kg/m^3 and mass 10 kg is suspended by a spring of stiffness 100 N/m. The other end of the spring is attached to a fixed support. The block is completely submerged in a liquid of density 1000 kg/m^3. If the block is in equilibrium position ($g = 10 m/s^2$).
(A) the elongation of the spring is 1 cm.
(B) the magnitude of buoyant force acting on the block is 50 N.
(C) the spring potential energy is 12.5 J.
(D) magnitude of spring force on the block is greater than the weight of the block.

20. Lower end of a capillary tube of radius 10^{-3} m is dipped vertically into a liquid. Surface tension of liquid is 0.5 N/m and specific gravity of liquid is 5. Contact angle between liquid and material of capillary tube is 120°. Choose the correct options (use $g = 10 m/s^2$)
(A) Maximum possible depression of liquid column in the capillary tube is 1 cm.
(B) Maximum possible depression of mercury column in the capillary tube is 2 cm.
(C) If the length of the capillary tube dipped inside mercury is half of the maximum possible depression of mercury column in the capilary tube, angle made by the mercury surface at the end of the capillary tube with the vertical, is $\cos^{-1}\left(-\frac{1}{4}\right)$.
(D) If the length of the capillary tube dipped inside mercury is one third of the maximum possible depression of mercury column in the capilary tube, angle made by the mercury surface at the end of the capillary tube with the vertical, is $\cos^{-1}\left(-\frac{1}{6}\right)$.

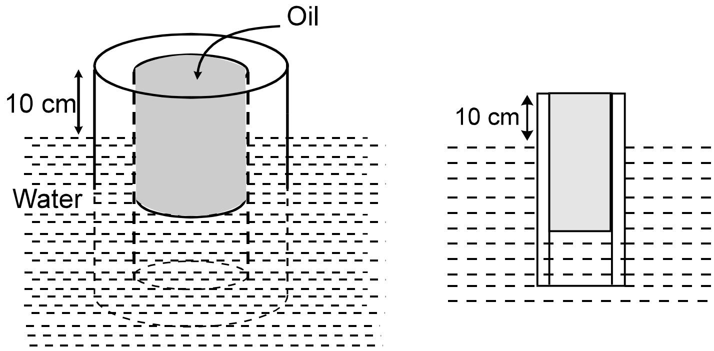
21. When a capillary tube is immersed into a liquid, the liquid neither rises nor falls in the capillary ?
(A) The angle of contact must be 90^0
(B) The angle of contact may be 90^0
(C) The surface tension of liquid must be zero
(D) The surface tension of liquid may be zero

22. A tank is filled by water ($\rho = 10^3$ kg/m^3). A small hole is made in the side wall of the tank at depth 10 m below water surface. A water jet emerges horizontal from the hole and falls at horizontal distance R from it. The amount of extra pressure (in terms of atmospheric pressure) that must be applied on the water surface, so that range becomes 3R on the on the ground will be (cross section area of hole is negligible and 1 atm = 10^5 Pa, $g = 10 m/s^2$)

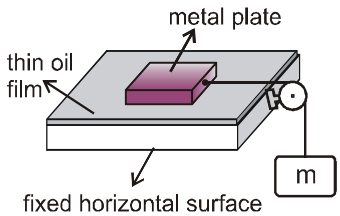
23. Figure shows a uniform metal ball suspended by thread of negligible mass from an upright cylinder that floats partially submerged in water. The cylinder has height 6 cm, face area 11 cm^2 on the top and bottom and density 0.5 g/cm^3. 4 cm of cylinder's height is inside the water surface. Density of the metal ball is 8gm/cm^3. R is the radius of the ball. It is found that $R^3 = \frac{3}{\alpha}$ cm^3, where α is an integer. Find α .(ρ_w = 1gm/cm^3)
(system is in equilibrium)



24. A tube with both ends open floats vertically in water. Oil with a density 800 kg/m^3 is poured into the tube. The tube is filled with oil upto the top end while in equilibrium. The portion out of the water is of length 10 cm. The length of oil in the tube is 10α cm. Find α (assume effect of surface tension is neglible):

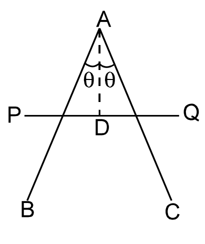


25. A rectangular metal plate has dimensions of 10 cm × 20 cm. A thin film of oil separates the plate from a fixed horizontal surface. The separation between the rectangular plate and the horizontal surface is 0.2 mm. An ideal string is attached to the plate and passes over an ideal pulley to a mass m. When m = 125 gm, the metal plate moves at constant speed of 5 cm/s across the horizontal surface. The coefficient of viscosity of oil in dyne–s/cm^2 is $\frac{\alpha}{2}$. Find α .(Use g=1000 cm/s^2)

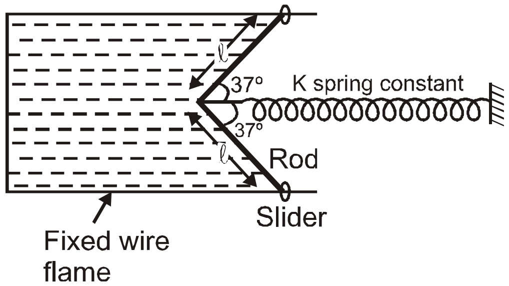


26. The velocity of liquid (v) in steady flow at a location through cylindrical pipe is given by $v = v_0\left(1-\frac{r^2}{R^2}\right)$, where r is the radial distance of that location from the axis of the pipe and R is the inner radius of pipe. If R = 10 cm. volume rate of flow through the pipe is $\pi/2 \times 10^{-2}$ m^{3}s^{-1} and the coefficient of viscosity of the liquid is 0.75 N sm^{-2}, find the magnitude of the viscous force per unit area, in Nm^{-2} at r = 4 cm.

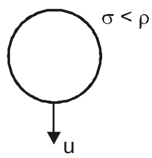
27. In the figure shown AB, BC and PQ are thin, smooth, rigid wires. AB and AC are joined at A and fixed in vertical plane. $\angle$BAC = 2θ = 90°and line AD is angle bisector of angle BAC. A liquid of surface tension T = 0.025 N/m forms a thin film in the triangle formed by intersection of the wires AB, AC and PQ. In the figure shown the uniform wire PQ of mass 1 gm is horizontal and in equilibrium under the action of surface tension and gravitational force. Find the time period of SHM of PQ in vertical plane for small displacement from its mean position, in the form $\frac{\pi}{X}$ s and fill value of X.



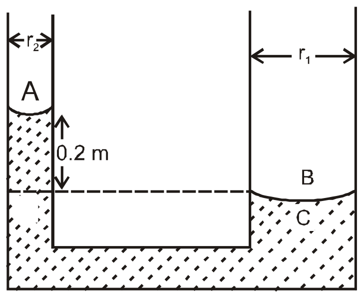
28. A rigid bent light rod of total length 2ℓ can slide on fixed wire frame with the help of frictionless sliders. There is thin liquid film (surface tension T) between bent rod and wire frame. In equilibrium the elongation in spring is given by $\left(\frac{4T\ell\alpha}{5K}\right)$. Then find the value of α.



29. A sphere of density ρ falls vertically downward through a fluid of density σ. At a certain instant its velocity is u. The terminal velocity of the sphere is u_0. Assuming that stokes's law for viscous drag is applicable, the instantaneous acceleration of the sphere is found to be $\beta\left(1-\frac{\sigma}{\rho}\right)\left(1-\frac{u}{u_0}\right)g$. Here β is an integer . Find β .

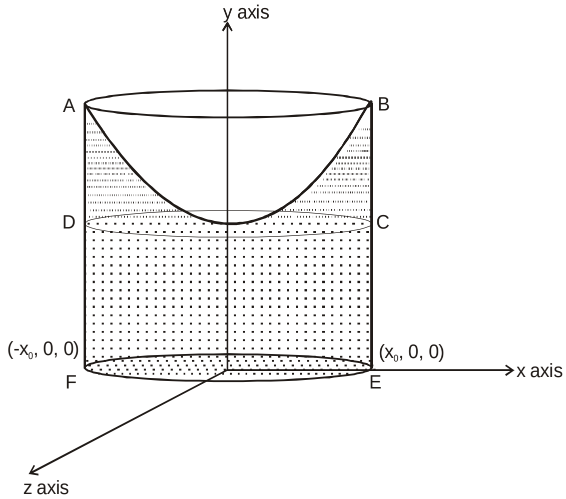


30. The limbs of a manometer consists of uniform capillary tubes of radii 1.44×10^{-3} m and 7.2×10^{-4} m. If the level of the liquid in the narrower tube stands 0.2 m above that in the broader tube, pressure difference between A and B is found to be 310λ N/m^2. Here λ is an integer. Find λ (density $= 10^3$ kg/m^3, surface tension $= 72 \times 10^{-3}$ N/m). (take g = 9.8 m/s^2)



COMPREHENSION-1

Consider a parabola $y = Ax^2 + B; -x_0 \le x \le x_0$.



If this curve is rotated about y axis, we get a paraboloid surface. The volume below this surface & above x–z plane is given by

$$V = \frac{\pi A x_0^4}{2} + \pi B x_0^2 = \frac{\text{volume of cylinder ABCD}}{2} + \text{volume of cylinder CDEF}$$

Use the above result to answer following question.

31. A cyllindrical container of height 'h' and radius 'a' is two-third filled. Find maximum angular velocity at which liquid can be rotated without spilling it.

(A) $\sqrt{\frac{4gh}{3a^2}}$ (B) $\sqrt{\frac{2gh}{3a^2}}$ (C) $\sqrt{\frac{gh}{a^2}}$ (D) $\sqrt{\frac{gh}{2a^2}}$

32. If the cylinder of previous problem was completely filled, then the minimum angular velocity at which base may be visible is.

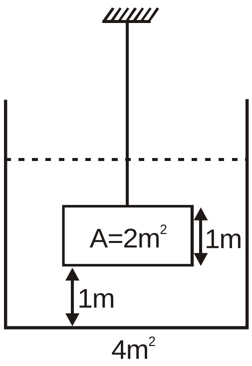
(A) $\sqrt{\frac{gh}{a^2}}$ (B) $\sqrt{\frac{2gh}{a^2}}$ (C) $\sqrt{\frac{gh}{2a^2}}$ (D) $\sqrt{\frac{4}{3}\frac{gh}{a^2}}$

33. In the above situation (i.e. fully filled cylinder of radius 'a' and height 'h'), if liquid is rotated at twice the angular velocity found in previous problem, then the amount of liquid left (after spillage) in the cylinder will be :

(A) $\frac{\pi a^2 h}{2}$ (B) $\frac{\pi a^2 h}{4}$ (C) $\frac{\pi a^2 h}{8}$ (D) $\frac{\pi a^2 h}{3}$

COMPREHENSION-2

A tank of base area 4 m^2 is initially filled with water up to height 2m. An object of uniform cross-section $2m^2$ and height 1m is now suspended by wire into the tank, keeping distance between base of tank and that of object 1m. Density of the object is $2000kg/m^3$. Take atmospheric pressure $1 \times 10^5 N/m^2$; $g = 10m/s^2$.



34. The downwards force exerted by the water on the top surface of the object is :

(A) 2.0×10^5 N (B) 2.1×10^5 N (C) 2.2×10^5 N (D) 2.3×10^5 N

35. The tension in the wire is :

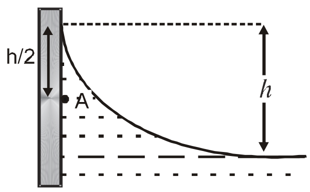
(A) 0.1×10^5 N (B) 0.2×10^5 N (C) 0.3×10^5 N (D) 0.4×10^5 N

36. The buoyant force on the object is :

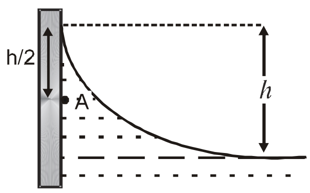
(A) 0.1×10^5 N (B) 0.2×10^5 N (C) 0.3×10^5 N (D) 0.4×10^5 N

COMPREHENSION-3

Water in a clean large cuboid aquarium forms a meniscus, as shown in the figure. The difference in height between the centre and the edge of the meniscus is h. Surface tension of water is $S = 0.073\ Nm^{-1}$. Atmospheric pressure is $P_0 = 10^5\ N/m^2$. Angle of contact between the water and aquarium wall is zero.



Answer the following 3 questions above illustrated situation.



37. Pressure at point A is

(A) $P_0 + \frac{\rho gh}{2}$ (B) $P_0 - \frac{\rho gh}{2}$ (C) $P_0 - \rho gh$ (D) P_0

38. For an aquarium with side walls of length ℓ ,horizontal force on the volume of water enclosed by the dashed line and free surface, by one aquarium wall is

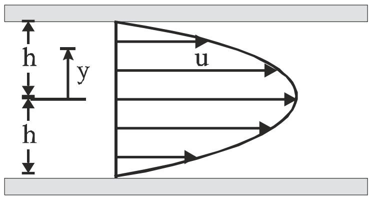
(A) $\left(P_0 - \frac{\rho gh}{2}\right)\ell h$ (B) $\left(P_0 + \frac{\rho gh}{2}\right)\ell h$ (C) $(P_0 - \rho gh)\ell h$ (D) $P_0\ell h$

39. Value of height h is

(A) 0.0076 m (B) 0.0019 m (C) 0.0038 m (D) 0.0152 m

COMPREHENSION-4

The velocity distribution for the flow of a Newtonian fluid between two wide, parallel plates is given by the equation



$$u = \frac{3V}{2}\left[1 - \left(\frac{y}{h}\right)^2\right]$$

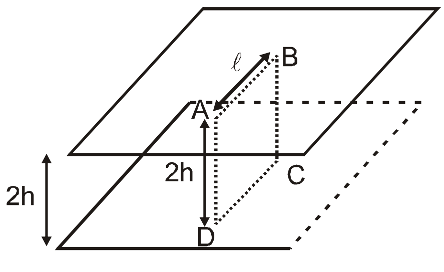
where V is the mean velocity. The fluid has coefficient of viscosity η.
Answer the following 3 questions for this situation.

40. Shear stress acting on the bottom wall is

(A) $\tau_{\substack{\text{bottom}\\\text{wall}}} = \eta\left(\frac{3V}{h}\right)$ (B) $\tau_{\substack{\text{bottom}\\\text{wall}}} = \eta\left(\frac{3V}{2h}\right)$

(C) $\tau_{\substack{\text{bottom}\\\text{wall}}} = \eta\left(\frac{6V}{h}\right)$ (D) $\tau_{\substack{\text{bottom}\\\text{wall}}} = \eta\left(\frac{V}{h}\right)$

41. Consider a rectangular cross section of dimensions $\ell \times 2h$ as shown. The side AB is parallel to the plates. Volume flow rate through this cross section is

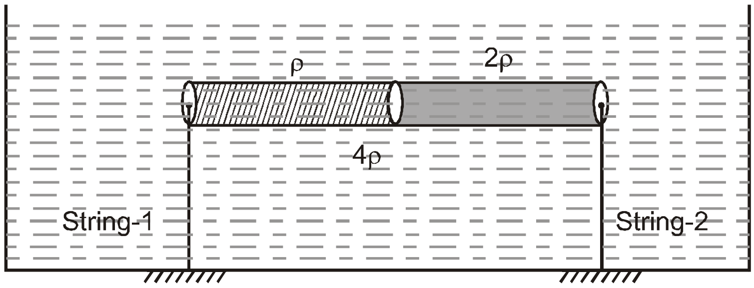


(A) $\ell hV/2$ (B) ℓhV (C) $2\ell hV$ (D) $3\ell hV$

42. Shear stress acting on a plane parallel to the walls and located at $y = \frac{h}{2}$ is

(A) $\tau = \eta\frac{3V}{h}$ (B) $\tau = \eta\frac{3V}{2h}$ (C) $\tau = \eta\frac{6V}{h}$ (D) $\tau = \eta\frac{V}{h}$

43. A rod is formed by joining two cylinders each having a length ℓ and cross sectional area S. The densities of cylinder are ρ and 2ρ respectively. The rod is now horizontally suspended in a liquid of density 4ρ with help of two string as shown in the figure. The entire setup is kept inside a lift. For the quantities given in List I select the correct value from those mentioned in List II.

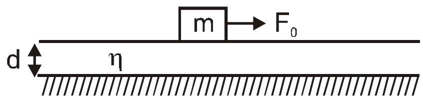


List I		List II
(P) Tension in string 1 if the lift is moving upwards with constant velocity.	(1)	$\frac{11}{8}\rho S\ell g$
(Q) Tension in string 2 if the lift is moving upwards with constant velocity	(2)	$\frac{9}{8}\rho S\ell g$
(R) Tension is string 1 if lift is moving downwards with an acceleration of g/2	(3)	$\frac{11}{4}\rho S\ell g$
(S) Tension in string 2 if the lift is moving downwards with an acceleration of g/2	(4)	$\frac{9}{4}\rho S\ell g$

Choose the correct option :

(A) P – 3, Q – 4, R – 1, S – 2
(B) P – 1, Q – 2, R – 3, S – 4
(C) P – 4, Q – 3, R – 2, S – 1
(D) P – 2, Q – 1, R – 4, S – 3

44. A cubical block of mass m and surface area 6A is placed on a thick layer of viscous liquid, of thickness d as shown.



Initially the block is at rest. A constant horizontal force F_0 starts acting on the block at t = 0.
In column - 1 a physical quantity regarding the motion of the block is given and in column-2 corresponding variation with time is given. Match the proper entries from column-2 to column-1 using the codes given below the columns.

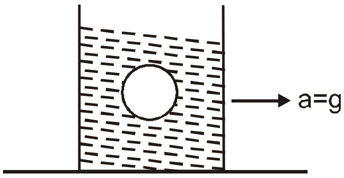
Column - 1	Column - 2
(P) X (distance travel by the block as function of time.)	(1) $\alpha\, e^{-\beta t}$ $(\alpha, \beta \neq 0)$
(Q) V (velocity of block as as function of time.)	(2) $\alpha + \beta t + \gamma\, e^{-\delta t}$ $(\alpha,\beta,\gamma,\delta \neq 0)$
(R) A (acceleration of block as as function of time.)	(3) $\alpha\, e^{-\beta t} - \gamma\, e^{-\delta t}$ $(\alpha,\beta,\gamma,\delta \neq 0)$
(S) dK/ dt (rate of change in kinetic energy of block as as function of time.)	(4) $\alpha + \beta e^{-\gamma t}$ $(\alpha,\beta,\gamma \neq 0)$

(here α, β, γ, δ may have different values in each of options)

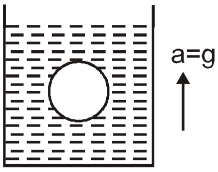
Codes :

	P	Q	R	S
(A)	2	1	3	4
(B)	2	4	1	3
(C)	2	4	3	1
(D)	1	2	4	3

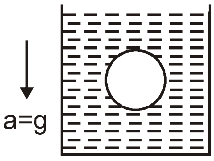
45. A ball of mass m and density $\frac{\rho}{2}$ is completely immersed in a liquid of density ρ, contained in an accelerating vessel as shown. Select the correct answer using the codes given below the columns.

(P) 

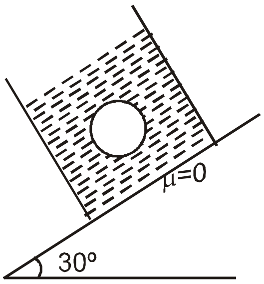
(1) force of buoyancy on ball is $2\sqrt{2}$ mg

(Q) 

(2) force of buoyancy is absent

(R) 

(3) liquid particles fall with respect to vessel

(S) 

(4) ball rise with respect to vessel

Codes :

	P	Q	R	S
(A)	1	3	2	4
(B)	4	1	2	3
(C)	3	4	2	1
(D)	1	4	3	2

ANSWER KEY OF DPP NO. # 06

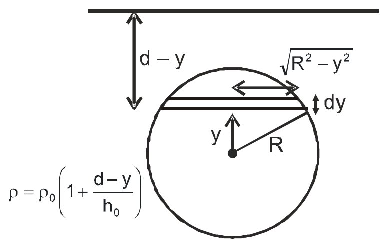
1.	(D)	**2.**	(A)	**3.**	(C)	**4.**	(A)	**5.**	(B)	**6.**	(D)	**7.**	(A)
8.	(C)	**9.**	(B)	**10.**	(D)	**11.**	(C)	**12.**	(C)	**13.**	(A)	**14.**	(A)
15.	(A)	**16.**	(C)	**17.**	(B,D)	**18.**	(A,B,C)	**19.**	(A,C,D)	**20.**	(A,B,D)		
21.	(A,B)	**22.**	(A,B,C,D)			**23.**	2	**24.**	4	**25.**	9	**26.**	4
27.	2	**28.**	5	**29.**	**1**	**30.**	**2**	**31.**	**5**	**32.**	20	**33.**	(A)
34.	(A)	**35.**	(B)	**36.**	(C)	**37.**	(C)	**38.**	(D)	**39.**	(C)	**40.**	(A)
41.	(A)	**42.**	(A)	**43.**	(A)	**44.**	(C)	**45.**	(A)				

Solution of DPP # 7

TARGET : JEE (ADVANCED) 2015
COURSE : VIJAY & VIJETA (ADR & ADP)

1. (1) In arrangement–1, water of weight ρVg gas come out, but the buoyancy force is also equal to the weight of displaced liquid. So, reading of weighing machine is W.
(2) In arrangement–2, weight of the ball mg is added, but water of weight $\rho_w Vg$ is removed so reading of weighing machine is W + mg – ρVg.

2. $dB = \pi(R^2 - y^2)dy \quad \rho_0\left(1+\frac{d-y}{h_0}\right)g$



$$dB = \frac{\pi\rho_0 g}{h_0}\,(R^2 - y^2)\,(h_0 + d - y)dy$$

$$= \frac{\pi\rho_0 g}{h_0}\,[R^2(h_0 + d)dy - R^2ydy - (h_0 + d)y^2dy + y^3dy]$$

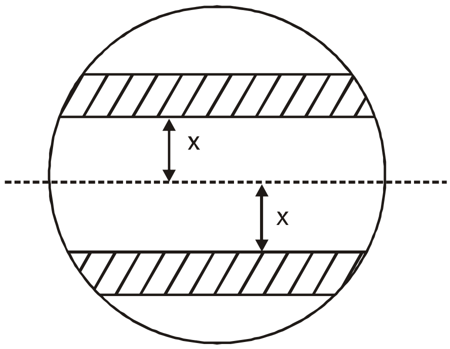
$$B = \int_{y=-R}^{+R} dB = \frac{\pi\rho_0 g}{h_0}\left(R^2(h_0+d)y - \frac{R^2y^2}{2} - (h_0+d)\frac{y^3}{3} + \frac{y^4}{4}\right)_{-R}^{+R}$$

$$B = \frac{\pi\rho_0 g}{h_0}\left[(h_0+d)R^2(2R) - \frac{(h_0+d)}{3}(2R^3)\right] \qquad = \frac{\pi\rho_0 g}{h_0}\left[\frac{4}{3}(h_0+d)R^3\right]$$

$$= \frac{4}{3}\pi R^3 g\,\frac{\rho_0}{h_0}(h_0+d) = \frac{4}{3}\pi R^3 g\sigma \quad \Rightarrow \quad \sigma = \frac{\rho_0}{h_0}(h_0+d)$$

$$\sigma = \rho_0\left(1+\frac{d}{h_0}\right)$$

Alternate solution



$$\sigma vg = \int\left[\rho_0\left(1+\frac{d-x}{h_0}\right)dvg + \rho_0\left(1+\frac{d+x}{h_0}\right)dvg\right]$$

$$\sigma v = 2\rho_0\left(1+\frac{d}{h_0}\right)\int_0^{v/2} dV = \rho_0 v\left(1+\frac{d}{h_0}\right)$$

$$\Rightarrow \qquad \sigma = \rho_0\left(1+\frac{d}{h_0}\right)$$

3. From Fig.(a) h_2A = volume of oil + some volume of ice

From Fig. (b) $h_2{}'A$ = volume of oil

$\Rightarrow$ $(h_2 - h_2{}')A$ = some volume of ice > 0

$\Rightarrow$ $h_2 > h_2{}'$

$\therefore$ Statement 3 correct

Pressure at bottom in fig. (a), is given by

$\Rightarrow$ $P_0 + \rho_{oil}\ h_2g + \rho_{water}\ h_1g$

$\therefore$ $(P_0 + \rho_{oil}\ h_2g + \rho_{water}h_1g)\ A = P_0A + W_{oil} + W_{water} + W_{ice}$ (i)

Similarly from fig. (b)

$(P_0 + \rho_{oil}\ h_2{}'g + \rho_{water}h_1{}'g)A = P_0A + W_{oil} + W_{water} + W_{ice}$ (ii)

$\rho_{oil}\ h_2{}' + \rho_{water}\ h_1{}' = \rho_{oil}\ h_2 + \rho_{water}\ h_1$

$\Rightarrow$ $\rho_{oil}(h_2 - h_2{}') = \rho_{water}(h_1{}' - h_1)$

$\Rightarrow$ $h_1{}' - h_1 = \dfrac{\rho_{oil}}{\rho_{water}}(h_2 - h_2{}') > 0$

$\therefore$ Statement 2 is correct.

Now fall in level $= |h_2 - h_2{}'|$

and rise in level $= |h_1{}' - h_1|$

$= \dfrac{\rho_{oil}}{\rho_{water}}(h_2 - h_2{}') < h_2 - h_2{}')$

$\Rightarrow$ Fall is more

Statement b is correct

4. $-A\dfrac{dy}{dt} = a\sqrt{2gy}$

$$\frac{2A}{a\sqrt{2g}}\left(\sqrt{H} - \sqrt{\frac{H}{n}}\right) = T_1$$

$$\frac{2A}{a\sqrt{2g}}\left(\sqrt{\frac{H}{n}} - 0\right) = T_2$$

$T_1 = T_2$

n = 4.

5. Upward force by capillary tube on top surface of liquid is

$f_{up} = 4\sigma a \cos\theta$

If liquid is raised to a height h then we use

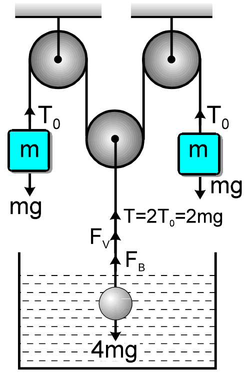
$4\sigma a \cos\theta = ha^2\rho g$ or $h = \dfrac{4\sigma\cos\theta}{a\rho g}$ **Ans.**

6. The only force acting on the body is the viscous force

Here $m\dfrac{vdv}{dx} = -6\pi\eta rv \quad = -rv$

$\Rightarrow \int_v^0 mdv = \int_0^x -rdx \qquad \Rightarrow x = \dfrac{mv}{r}$.

7. From the free body diagram of the sphere :



$F_V = 4\text{ mg} - 2\text{ mg} - F_B$

$\Rightarrow \quad F_V = 2\text{ mg} - F_B$

$\Rightarrow \quad 6\,\pi\,\eta\,r\,V = \dfrac{4}{3}\pi r^3\left(\dfrac{\sigma}{2} - \rho\right)g$

(since $4m = \dfrac{4}{3}\pi r^3 \times \sigma$)

$\Rightarrow \quad V = \dfrac{1}{9}\dfrac{r^2(\sigma - 2\rho)g}{\eta}$

8. Let the density of water be ρ, then the force by escaping liquid on container = $\rho S(\sqrt{2gh})^2$

$\therefore$ acceleration of container a = $\dfrac{2\rho Sgh - \mu\rho Vg}{\rho V} = \left(\dfrac{2Sh}{V} - \mu\right)g$

Now $\mu = \dfrac{Sh}{V} \qquad \therefore a = \dfrac{Sh}{V}g$

9. Viscous force = mg sin θ

$\therefore \eta A\,\dfrac{v}{t} = mg\sin\theta \qquad$ or $\qquad \eta a^2\,\dfrac{v}{t} = a^3\rho g\sin\theta$

$\eta = \dfrac{t\rho g\sin\theta a}{v}$

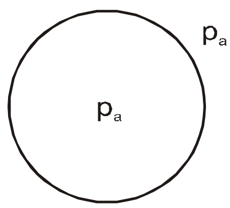
10. Relative to liquid, the velocity of sphere is $2v_0$ upwards.

$\therefore$ viscous force on sphere $= 6\,\pi\,\eta\,r\,2v_0$ downward

$= 12\,\pi\,\eta\,r\,v_0$ downward

11. The force exerted by film on wire or thread depends only on the nature of material of the film and not on its surface area. Hence the radius of circle formed by elastic thread does not change.

12. (B) Inside pressure must be $\dfrac{4T}{r}$ greater than outside pressure in bubble. This excess pressure is provided by charge on bubble.



$\dfrac{4T}{r} = \dfrac{\sigma^2}{2\varepsilon_0}$

$\dfrac{4T}{r} = \dfrac{Q^2}{16\pi^2 r^4 \times 2\varepsilon_0} \qquad \ldots\ldots \left[\sigma = \dfrac{Q}{4\pi r^2}\right]$

$Q = 8\pi r\sqrt{2rT\varepsilon_0}$

13. Isothermal process.

$$\left(P_1+\frac{4T}{r}\right)\left(\frac{4}{3}\pi r^3\right)=\left(P_2+\frac{4T}{r/2}\right)\left(\frac{4}{3}\pi(r/2)^3\right)$$

$$P_2 = 8P_1 + \frac{24T}{r}$$

14. Given :
Initial radius of soap bubble = R
Surface tension of soap solution = T
Final radius of soap bubble = 2R
The initial energy needed to blow the soap bubble is
$E_1 = 2 \times 4\pi\ R^2 \times T = 8\pi\ R^2\ T$
and final energy needed to blow the soap bubble is
$E_2 = 2 \times 4\pi\ (4R)^2 = 32\pi\ R^2T$
Hence extra energy is needed is given by
$E_2 - E_1 = 32\pi\ R^2T - 8\pi\ R^2T = 24\pi\ R^2T$

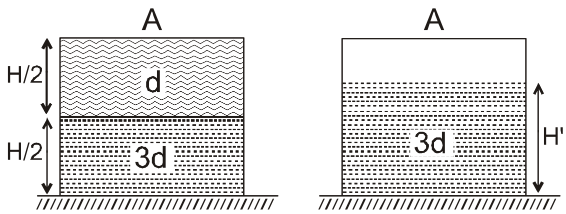
15. Let v be the velocity of the movable plate and F is equal to viscous force

$$F = \left[\eta_1\frac{v}{h_1}+\eta_2\frac{v}{h-h_1}\right]A \Rightarrow \frac{dF}{dh_1} = 0 \qquad \therefore h_1 = \frac{h}{3}$$

16. A, B, D

$$\frac{H}{2}\times d+\frac{H}{2}\times 3d = H'\times 3d$$

$$\Rightarrow H' = \frac{2H}{3}$$



$$V_{efflux} = \sqrt{2g(H'-h)}$$

V_{efflux} is maximum when h = H'/2

$$\therefore \quad V_{max} = \sqrt{\frac{2gH}{3}}$$

$$\text{Range } R = V_{efflux}\times\sqrt{\frac{2(H'-h)}{g}}$$

$$R_{max} = \frac{2H}{3}$$

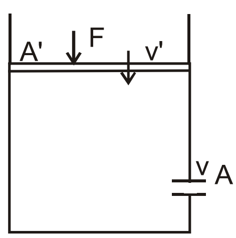
17.

$$\frac{F}{A}+\frac{1}{2}\rho v'^2 = \frac{1}{2}\rho v^2 \qquad \text{(i)}$$

$A'v' = Av$ (ii)

$\therefore\ F \propto v^2$ (A)

$P = F \cdot v'$ (B)



$$Av = \text{volume flow rate} = \frac{\text{volume}}{t}$$

$$\therefore\ t \propto \frac{1}{v} \qquad \text{(C)}$$

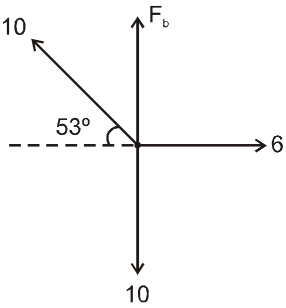
W.D. = ΔK $\Rightarrow$ (D)

18. $F_{drag} = 6\pi\eta RV$

$= 6\pi \dfrac{20}{6\pi} \times 0.1 \times 5 = 10$ N

$F_b + 8 = 10$

$F_b = 2$

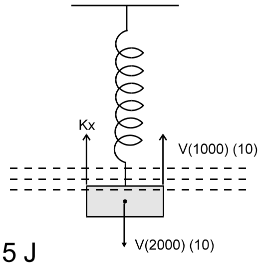


19. $Kx = V(2000)(10) - V(1000)(10)$

$= \dfrac{10}{2000}[1000 \times 10]$

$Kx = 50$ N ... (b)

$U_{stored} = \dfrac{1}{2} \times (100)\left(\dfrac{50}{100}\right)^2 = \dfrac{1}{2} \times \dfrac{2500}{100} = 12.5$ J



20. $S = 0.5$ N/m $\quad r = 10^{-3}$ m $\quad \theta_C = 120°$ $\quad \rho = 5 \times 10^3$ kg/m^3

$$h_{,max} = \frac{2S\cos\theta_c}{r\rho g} = \frac{(2)\left(\frac{1}{2}\right)\left(-\frac{1}{2}\right)}{(10^{-3})(5\times10^3)(10)} = 10^{-2} \text{ m} = 1\text{cm}$$

If $\quad h = \dfrac{h_{max}}{2}$

$$\frac{2S\cos\theta}{r\rho g} = \frac{1}{2}\frac{2S\cos\theta_c}{r\rho g}$$

$\Rightarrow \quad \cos\theta = -\dfrac{1}{4}$

$\theta = \cos^{-1}\left(-\dfrac{1}{4}\right)$

If $\quad h = \dfrac{h_{max}}{3}$

$$\frac{2S\cos\theta}{r\rho g} = \frac{1}{3}\frac{2S\cos\theta_c}{r\rho g}$$

$\Rightarrow \quad \cos\theta = -\dfrac{1}{6}, \qquad \theta = \cos^{-1}\left(-\dfrac{1}{6}\right)$

21. $h = \dfrac{2T\cos\theta}{\rho gr}$

22. $\rho gh = 1/2\ \rho v_1^2$ ....(1)

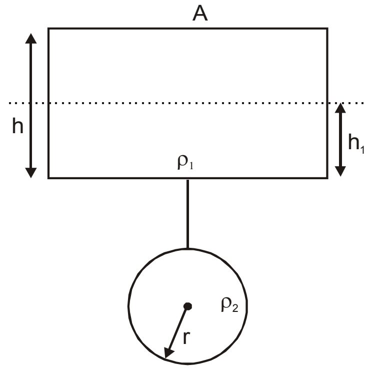
$\Delta P = \rho gh = 1/2\ \rho v_2^2$ ....(1)

$v_2 = 3v_1 \Rightarrow v_2^2 = 9v_1^2$

$\Rightarrow \quad \dfrac{1}{2}\rho v_2^2 = 9\left(\dfrac{1}{2}\rho v_1^2\right) \quad \Rightarrow \quad \Delta P + \rho gh = 9\rho gh$

$\Delta P = 8\rho gh = 8 \times 10^3 \times 10 \times 10 = 8 \times 10^5$ pascal = 8 atm

23. Taking cylinder and the ball as system



$$\frac{4}{3}\pi R^3 . \rho_2 . g + Ah.\rho_1 g = \frac{4}{3}\pi R^3 . \rho_w . g + Ah_1.\rho_w g$$

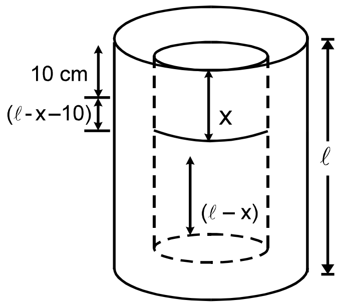
$$\to R = \left[\frac{3A(h_1\rho_\omega - h\rho_1)}{4\pi(\rho_2 - \rho_w)}\right]^{1/3}$$

using values

$A = 11\ cm^2$; $h_1 = 4$ cm ; $\rho_w = 1\ gm/cm^3$;
$\rho_1 = 0.5\ gm/cm^3$; $\rho_2 = 8 gm/cm^3$

$$R = \left[\frac{3\times 11(4\times 1 - 6\times 0.5)}{4\times\left(\frac{22}{7}\right)\times(8-1)}\right]^{1/3} = \left(\frac{3}{8}\right)^{1/3} cm \quad \Rightarrow \quad R^3 = 3/8$$

24. After oil is filled up, pressure at the depth of lower end should equate if measured from inside and outside the tube. Suppose depth of oil is x cm then :



$1000.g. [(\ell - 10)cm] = 800\ g. (x\ cm) + 1000\ g[(\ell - x)cm] \quad \Rightarrow \quad x = 50$ cm

25. The coefficient of viscosity is the ratio of tangential stress on top surface of film (exerted by block) to that of velocity gradient(vertically downwards) of film. Since mass m moves with constant velocity, the string exerts a force equal to mg on plate towards right. Hence oil shall exert tangential force mg on plate towards left.

$$\therefore\ \eta = \frac{F/A}{(v-0)/\Delta x} = \frac{125\times 1000/10\times 20}{(5-0)/.02} = 2.5\ \text{dyne–s/cm}^2$$

26. Magnitude of viscous force, $F = \eta A\ \frac{dv}{dr}$

$\Rightarrow$ viscous force per unit area $\sigma = \frac{F}{A} = \eta\frac{dv}{dr}$

$$v = v_0\left(1 - \frac{r^2}{R^2}\right) \Rightarrow \frac{dv}{dr} = -\frac{2V_0 r}{R^2} \Rightarrow \sigma = \eta\cdot\frac{2v_0 r}{R^2} \quad ......(i)$$

Volume rate of flow, Q

consider an annular element at r from axis, width dr.

$$dA = 2\pi r dr\ ;\ dQ = v.dA = v_0\left(1 - \frac{r^2}{R^2}\right)2\pi r dr$$

$$Q = \int dQ = 2\pi v_0\left[\frac{r^2}{2} - \frac{r^4}{4R^2}\right]_0^R = \frac{\pi}{2}R^2 v_0 \quad \Rightarrow \quad v_0 = \frac{2Q}{\pi R^2}$$

$$\therefore \quad (i) \quad \Rightarrow \quad \sigma = \eta\frac{4Q}{\pi R^4}\ r,\ R = 0.1\ m$$

At r = 0.04 m , $\sigma = (0.75)\ 4 \times \frac{\pi}{2} \times 10^{-2} \times \frac{0.04}{\pi\times 10^{-4}} = 6\ Nm^{-2}$

27. The F.B.D. of wire PQ is

The force due to surface tension = F_{ST} = 2T × 2 AD tanθ

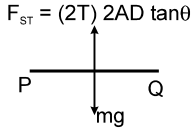


Figure (a)

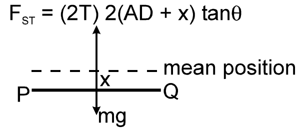


Figure (b)

For wire to be in equilibrium (Figure (a))

$4T\,AD\tan\theta = mg$ .... (1)

If the wire PQ is at a distance x below the mean position, the restoring force on the wire is (Figure (b))

$-ma = 4T\tan\theta\,(AD + x) - mg = 4T\tan\theta\, x$

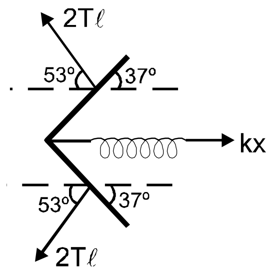
Hence the wire PQ executes SHM

$$a = -\frac{4T}{m}\tan\theta\ \ x$$

comparing with $a = -\omega^2 x$ we get

$$\omega^2 = \frac{4T}{m}\tan\theta$$

or $$T = 2\pi\sqrt{\frac{m}{4T\tan\theta}} = 2\pi\sqrt{\frac{1\times10^{-3}}{4\times25\times10^{-3}}} = \frac{\pi}{5}\text{ s}$$

28. 

$2(2T\ell)\cos 53^\circ = Kx$

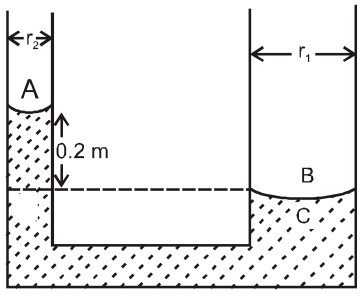
$$\frac{4T\ell 3}{5K} = x.$$

29. $F_d = 6\pi\mu r u$

$$F_B = \frac{4}{3}\pi r^3\sigma g\ ,\ mg = \frac{4}{3}\pi r^3\rho g$$

$$mg - F_d - F_B = ma\ ;\ u_0 = \frac{2r^2}{9}g\frac{(\rho-\sigma)}{\mu}$$

$$\therefore \quad a = \left(1-\frac{\sigma}{\rho}\right)\left(1-\frac{u}{u_0}\right)g$$

30. 

$r_1 = 1.44 \times 10^{-3}$ m. $\quad r_2 = 0.72 \times 10^{-3}$ m.

Equating pressures at points (B) & (C)

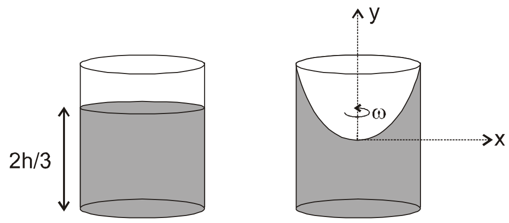
$P_A - \frac{2\sigma}{r_2} + (0.2)\,\rho g = P_C.$ and $P_B - \frac{2\sigma}{r_1} = P_C.$

so $\quad P_B - P_A \quad = 2\sigma\left(\frac{1}{r_1} - \frac{1}{r_2}\right) + 0.2\,\rho g$

$$= 2 \times 72 \times 10^{-3}\ \frac{N}{m}\left[\frac{10^3}{1.44} - \frac{10^3}{0.72}\right] + (0.2) \times 10^3 \times 938$$

$$= \frac{144 \times (-0.72)}{1.44 \times 0.72} + 1960 \quad = \ -100 + 1960 = 1860\ N/m^2.$$

31. Profile of rotating liquid is given by



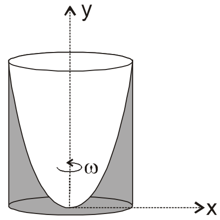
$$y = \frac{\omega^2 x^2}{2g}$$

Putting x = a, $y = \frac{\omega^2 a^2}{2g}$

Volume of liquid in fig. (b) is written as = $\dfrac{\pi a^2 \times \dfrac{\omega^2 a^2}{2g}}{2} + \pi a^2\left(h - \dfrac{\omega^2 a^2}{2g}\right)$

Equating to volume in figure (a), we get

$$\pi a^2 \frac{2h}{3} = \frac{\pi a^2 \omega^2 a^2}{4g} + \pi a^2\left[h - \frac{\omega^2 a^2}{2g}\right] \quad \Rightarrow \quad \omega = \sqrt{\frac{4gh}{3a^2}}$$

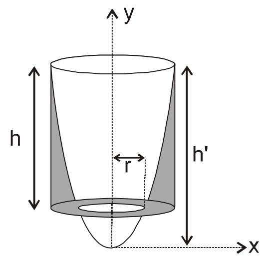


32. $y = \frac{\omega^2 x^2}{2g}$

$h = \frac{\omega^2 a^2}{2g}$

$\omega = \sqrt{\frac{2gh}{a^2}}$

33. Some base area will be visible. Let radius of visible base be 'r'.
Origin shifts below base.
Put x = a & y = h'



$h' = \frac{\omega^2 x^2}{2g} = \frac{8gh}{a^2} \times \frac{a^2}{2g} = 4h$

put x = r & y = h' – h = 3h

$3h = \frac{8gh}{a^2} \times \frac{r^2}{2g} \quad \Rightarrow \quad r^2 = \frac{3}{4}a^2$

$V_{left} = \frac{\pi a^2 h^1}{2} - \left[\pi(a^2 - r^2)(h' - h) + \frac{\pi r^2 (h' - h)}{2}\right] \qquad = \frac{\pi a^2 h}{8}$

34 to 36

(i) By conservation of volume

$4 \times h = 4 \times 2 + 2 \times 1 = 10$

h = 2.5m

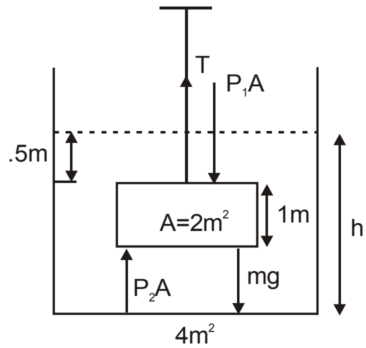
Pressure at top of the object

$= P_0 + 0.5 \times 1000 \times 10$

$= 1.05 \times 10^5$ N/m²

$F = P_1 A$

$= 1.05 \times 10^5 \times 2 = 2.1 \times 10^5$ N



By F.B.D. $\quad T + P_2A = mg = P_1A$

$T = mg + (P_1 - P_2)A$

$= mg - (P_2 - P_1)A$

$= 2 \times 2000 \times 10 - (.2 \times 10^5)$

$= .4 \times 10^5 - 0.2 \times 10^5 = 0.2 \times 10^5$ N

$F_b = V.\rho_w g$

$= 2 \times 1000 \times 10 = 0.2 \times 10^5$ N

It is also equal to net contact force by the liquid $= P_2A - P_1A$

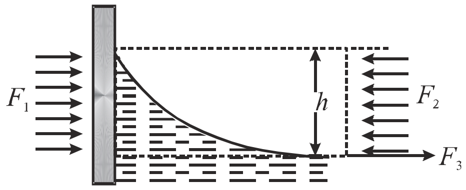
$= 0.2 \times 10^5$N

Note : Net contact force and buoyant force are same.

37-39

The pressure of the water changes linearly with the increase in height. At the bottom of the meniscus it is equal to the external atmospheric pressure p_0, and at the top to . The average pressure exerted on the wall is $p_{average} = p_0 - \rho gh/2$. The force corresponding to this value, for an aquarium with side walls of length ℓ, is $F_1 = p_{average}\ell h$.

Consider the horizontal forces acting on the volume of water enclosed by the dashed lines in the figure. The wall pushes it to the right with force F_1, the external air pushes it to the left with force F_2 $\pi_0\ell h$, and the surface tension of the rest of the water pulls it to the right with a force $F_3 = \ell s$. The resultant of these forces has to be zero, since the volume itself is at rest. This means that



$\left(p_0 - \frac{1}{2}\rho gh\right)\ell h - p_0\ell h + \ell s = 0$,

which we can write as

$$h = \sqrt{\frac{2s}{\rho g}} = \sqrt{\frac{2 \times 0.073}{1000 \times 10}} = 0.0038 \text{ m}.$$

water rises by approximately 4 mm up the wall of the aquarium.

$$\left(p_0 - \frac{1}{2}\rho gh\right)\ell h - p_0\ell h + \ell s = 0,$$

which we can write as $h = \sqrt{\frac{2s}{\rho g}} = \sqrt{\frac{2 \times 0.073}{1000 \times 10}} = 0.0038 \text{ m}$

40 to 42

For this type of parallel flow the shearing stress is given as

$$\tau = \eta \frac{du}{dy} \qquad \ldots(i)$$

For the given distribution

$$\frac{du}{dy} = -\frac{3Vy}{h^2} \qquad \ldots(ii)$$

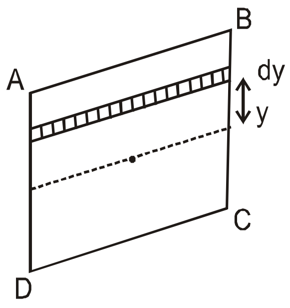
(a) Along the bottom wall so that (from eq. ii)

$\frac{du}{dy} = \frac{3V}{h}$ and therefore the shearing stress is $\tau_{\substack{\text{bottom}\\ \text{wall}}} = \eta\left(\frac{3V}{h}\right)$

(b) Along the plane where y = h/2 it follows from equation (ii)that

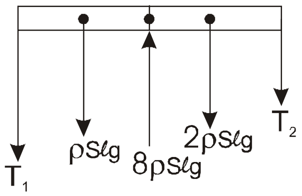
$\frac{du}{dy} = \frac{-3Vy}{h^2}$ and thus the shearing stress is $|\tau| = \eta\frac{3V}{2h}$.

(C)



Rate of volume flow $2\int_0^h \frac{3V}{2}\left(1 - \frac{y^2}{h^2}\right)dy.\ell = 2V\ell h$

43. Consider the FBD shown in the figure.



Force balance

$\Rightarrow \quad T_1 + T_2 = 5\rho S\ell g$

Torque balance about point P

$\Rightarrow \quad T_1 \times 2\ell + \rho S\ell g \times 3/2\ell - 8\rho S\ell g \times \ell/2 = 0$

$T_1 = 11/4\,\rho S\ell g$

$\Rightarrow \quad T_2 = 9/4\rho S\ell g$

$g_{eff} = g - g/2 = g/2$

44. $F = mA = F_0 - F_v = F_0 - \dfrac{\eta A v}{d}$

$A = \dfrac{F_0}{m} - \dfrac{\eta A}{md}\, v = a - bv$

$\dfrac{dv}{dt} = a - b\,v \quad \Rightarrow \quad \displaystyle\int_0^v \frac{dv}{a - bv} = \int_0^t dt$

$\Rightarrow \left(-\dfrac{1}{b}\right) \ell n \left(\dfrac{a - bv}{a}\right) = t \Rightarrow V = \dfrac{a}{b}\,(1 - e^{-bt})$

$\dfrac{dx}{dt} = \dfrac{a}{b}\,(1 - e^{-bt}) \Rightarrow \displaystyle\int_0^x dx = \frac{a}{b}\int_0^t (1 - e^{-bt})\,dt$

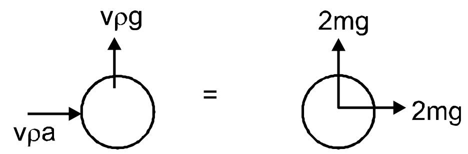
$x = \dfrac{a}{b}t - \dfrac{a}{b^2} + \dfrac{a}{b^2}e^{-bt}$

$A = ae^{-bt}$

$k = \dfrac{1}{2}\,mv^2$

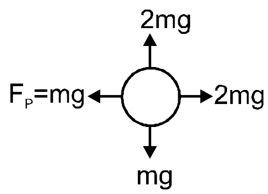
$\dfrac{dk}{dt} = m\,v\,\dfrac{dv}{dt} = \dfrac{ma}{b}\,(1 - e^{-bt})\,(ae^{-bt}) = \dfrac{ma^2}{b}\,(e^{-bt} - e^{-2bt})$

45. **(P)**



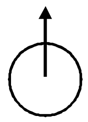
$F_B = \sqrt{2}\,(2mg)$

w.r.t. vessel

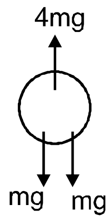


(P) – 1,3,4

(Q) $F_B = v\rho(g + g) = 4mg$



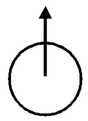
w.r.t. vessel



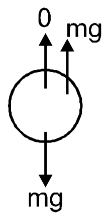
(Q) – 3,4

(R) $F_B = v\rho(g - g) = 0$

w.r.t. vessel

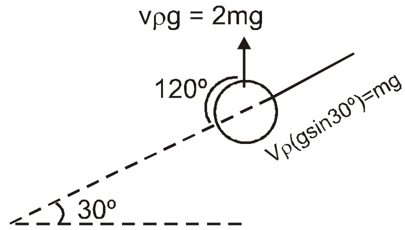


w.r.t. vessel



(R) – 2

(S) $F_B = v\rho g = 2mg$



$F_B = v\rho g = 2mg$

$$F_B = \sqrt{(2mg)^2 + (mg)^2 - 2mg \times mg \times 2 \times \frac{1}{2}}$$

$F_B = \sqrt{3}\ mg$

$$F_R = \sqrt{(mg)^2 + (mg)^2 + 2(mg)(mg) \times \frac{1}{2}}$$

$F_R = \sqrt{3}\ mg$

(S) – 3,4