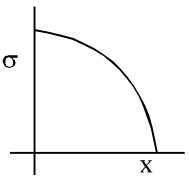
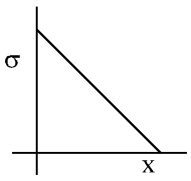
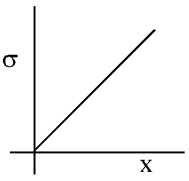
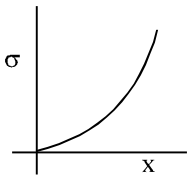
PROPERTIES OF MATTER AND FLUID MECHANICS

1. A uniform rod of mass 'M' and length L is hanging from a ceiling. The variation of tensile stress with distance X from the ceiling is best represented by

(1) 

(2) 

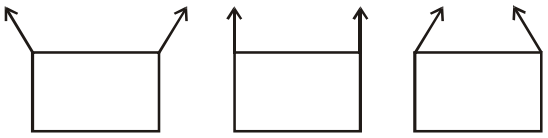
(3) 

(4) 

2. A man grows into a giant such that his linear dimensions increase by a factor of 9. Assuming that his density remains same, the stress in the leg will change by a factor of :

(1) 81 (2) $\frac{1}{81}$ (3) 9 (4) $\frac{1}{9}$

3. A rectangular frame is to be suspended symmetrically by two strings of equal length on two supports. It can be done in one of the following three ways :-



(a) (b) (c)

The tension in the strings will be

(1) the same in all cases

(2) least in (a)

(3) least in (b)

(4) least in (c)

4. The temperature of a wire is doubled. The young's modulus of elasticity :-

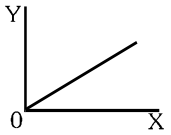
(1) will also double

(2) will increase

(3) will remain same

(4) will decrease

5. A student plots a graph from his readings on the determination of Young's modulus of a metal wire but forgets to put the labels (figure). The quantities on X and Y-axes may be respectively



(1) weight hung and length increased

(2) stress applied and length increased

(3) stress applied and strain developed

(4) All of these

6. A steel cable with a radius of 1.5cm supports a lift. If the maximum stress is not to exceed 10^8 N/m^2, maximum load the cable can support is :-

(1) 9×10^3N (2) 7×10^3N

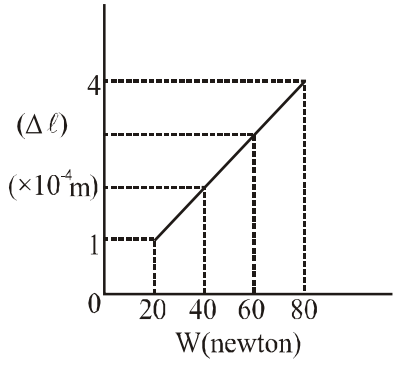
(3) 7.1×10^4N (4) 4×10^6N

7. Two wires of the same material and length but diameter in the ratio 1 : 2 are stretched by the same force. The ratio of potential energy per unit volume for the two wires when stretched will be:

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

(3) 4 : 1 (4) 16 : 1

8. The given graph shows the extension (Δl) of a wire of length 1.0 m suspended from the top of a roof at one end and a load be connected to the other end. If the cross-sectional area of the wire is 10^{-6} m^2, the Young's modulus (Y) of the material of the wire must be :-



(1) 2×10^{11} N/m^2 (2) 2×10^{12} N/m^2

(3) 3×10^{12} N/m^2 (4) 2×10^7 N/m^2

9. A copper and a steel wire of the same diameter are connected end to end. A deforming force F is applied to this composite wire which causes a total elongation of 1 cm the two wires will have :-

(1) the same stress

(2) different stress

(3) the same strain

(4) slope of stress strain curve will be same

10. How much should the pressure on a litre of water be changed to compress it by 0.10 % ? (Bulk modulus of water is 2.2×10^9 N/m^2)

(1) 2.2×10^5 N/m^2

(2) 2.2×10^4 N/m^2

(3) 2.2×10^6 N/m^2

(4) 2.2×10^8 N/m^2

11. The edge of an aluminium cube is 10cm long. One face of the cube is firmly fixed to a vertical wall. A mass of 100kg is then attached to the opposite face of the cube. The shear modulus of aluminium is 25GPa. What is the vertical deflection of this face ?

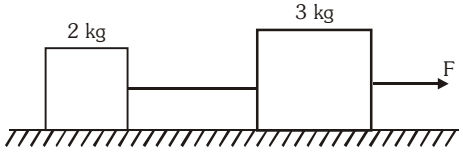
(1) 4.8×10^{-5} m

(2) 6.2×10^{-3} m

(3) 3.92×10^{-7} m

(4) 5×10^{-5} m

12. Two bodies of masses 2 kg and 3 kg are connected by a metal wire of cross section 0.04 mm^2. Breaking stress of metal wire is 2.5 GPa. The maximum force F that can be applied to 3 kg block so that wire does not break is :



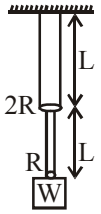
(1) 100 N

(2) 150 N

(3) 200 N

(4) 250 N

13. Two wire of the same material (young's modulus = Y) and same length 'L' but radii R and 2R respectively are joined end to end and a weight W is suspended from the combination as shown in the figure. The elastic potential energy in the system is :-



(1) $\frac{3W^2L}{4\pi R^2Y}$

(2) $\frac{3W^2L}{8\pi R^2Y}$

(3) $\frac{5W^2L}{8\pi R^2Y}$

(4) $\frac{W^2L}{\pi R^2Y}$

14. When an air bubble of radius r rises from the bottom to the surface of a lake, its radius becomes $\frac{5r}{4}$. Taking the atmospheric pressure to be equal to 10 m height of water column, the depth of the lake would approximately be (ignore the suface tension and the effect of temperature) :

(1) 11.2 m

(2) 8.7 m

(3) 9.5 m

(4) 10.5 m

15. The workdone in increasing the length of a one metre long wire of cross-sectional area 1 mm^2 through 1 mm will be (Y = 2 x 10^{11} Nm^{-2}) :

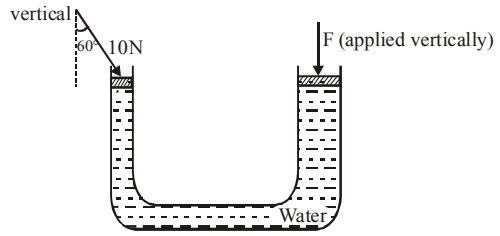
(1) 0.1 J

(2) 5 J

(3) 10 J

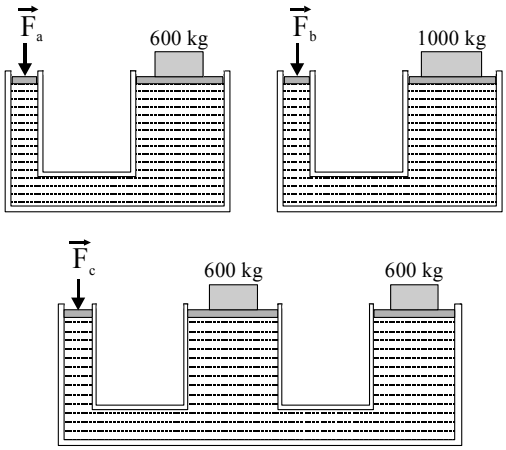
(4) 250 J

16. The area of cross-section of the two vertical arms of a hydraulic press are 1 cm^2 and 10 cm^2 respectively. A force of 10 N applied, as shown in the figure, to a tight fitting light piston in the thinner arm balances a force F applied to the corresponding piston in the thicker arm. Assuming that the levels of water in both the arms are the same, we can conclude :-



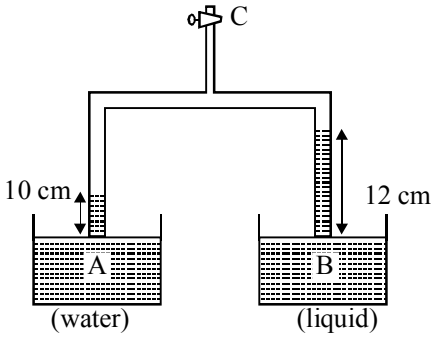
(1) F = 100 N
(2) F = 50 N
(3) F = 25 N
(4) F, as applied, cannot balance the effect of the force on the first piston

17. Rank in order, from largest to smallest, the magnitudes of the forces $\vec{F}_a$, $\vec{F}_b$ and $\vec{F}_c$ required to balance the masses. The masses (on same area) are in kilograms.



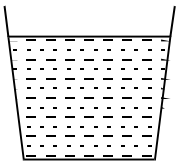
(1) $F_a = F_b = F_c$
(2) $F_a > F_b = F_c$
(3) $F_b > F_a = F_c$
(4) $F_c > F_a > F_b$

18. The limbs of a U-tube glass are lowered into vessels A and B, A containing water. Some air is pumped out through the top of the tube C. The liquids in the left hand limb A and the right hand limb B rise to heights of 10 cm and 12 cm respectively. The density of liquid B is



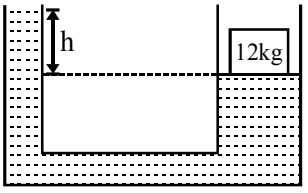
(1) 0.75 g/cm^3 (2) 0.83 g/cm^3
(3) 1.2 g/cm^3 (4) 0.25 g/cm^3

19. A liquid of mass 1 kg is filled in a flask as shown in figure. The force exerted by the flask on the liquid is (g = 10 m/s^2) [Neglect atmospheric pressure]:



(1) 10 N
(2) greater than 10N
(3) less than 10N
(4) zero

20. The area of cross section of the wides tube shown in the figure is 800 cm^2. If a mass of 12 kg is placed on the massless piston, the difference in the heights h in the level of water in two tubes :



(1) 10 m (2) 6 cm (3) 15 cm (4) 2 cm

21. You are holding a bottle of sparking water inside a car moving forward. When the driver applies the brakes :-

(1) Bubbles in the middle of the liquid will start to move forward with respect to the bottle.

(2) Bubbles will start to move backward with respect to the bottle.

(3) Bubbles will stay at the same horizontal location in the water.

(4) Depending on the speed of the car, bubbles might move forward or backward.

22. An object of specific gravity ρ is hung from a massless string. The tension in the string is T. The object is immersed in water so that one half of its volume is submerged. The new tension in the string is-

(1) $\left(\frac{2\rho+1}{2\rho}\right)T$

(2) $\left(\frac{2\rho-1}{2\rho}\right)T$

(3) $\left(\frac{\rho-1}{\rho}\right)T$

(4) $\left(\frac{\rho+1}{\rho}\right)T$

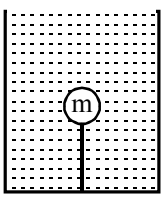
23. A solid sphere of density η (> 1) times lighter than water is suspended in a water tank by a string tied to its base as shown in the figure. If the mass of sphere is m then tension in the string is given by:-

(1) $\left(\frac{\eta-1}{\eta}\right)mg$

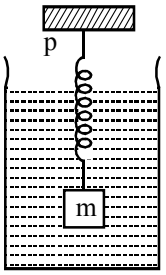
(2) η mg

(3) $\frac{mg}{(\eta-1)}$

(4) (η – 1) mg



24. A cube of mass m and density D is suspended from a point P by a spring of stiffness k. the system is kept inside a beaker filled with a liquid of density d. The elongation in the spring, assuming D > d, is :



(1) $\frac{mg}{k}\left(1-\frac{d}{D}\right)$ (2) $\frac{mg}{k}\left(1-\frac{D}{d}\right)$

(3) $\frac{mg}{k}\left(1+\frac{d}{D}\right)$ (4) $\frac{mg}{k}\left(1+\frac{D}{d}\right)$

25. A solid floats in a liquid in a partially dipped position

(1) The solid exerts a force equal to its weight on the liquid.

(2) The liquid exerts a force of buoyancy on the solid which is equal to the weight of the solid.

(3) The weight of the displaced liquid equals the weight of the solid.

(4) All of these

26. A and B are two metallic pieces. They are fully immersed in water and then weighed. Now they show same loss of weight. The conclusion therefore is

(1) By this information we cannot compare between their weight in air

(2) A and B have equal volume in air

(3) By this information we cannot compare between there density

(4) All of these

27. A wooden block floats in a liquid with 40% of its volume inside the liquid. When the vessel containing the liquid starts rising upwards with acceleration a = g/2, the percentage of volume inside the liquid is

(1) 20% (2) 60% (3) 30% (4) 40%

28. Spheres of iron and lead having same mass are completely immersed in water. Density of lead is more than that of iron. Apparent loss of weight is W_1 for iron sphere and W_2 for lead sphere. Then $\frac{W_1}{W_2}$ is :-

(1) = 1 (2) between 0 and 1

(2) = 0 (4) > 1

29. A little masked girl is holding a helium-filled balloon with a string while riding in a closed elevator going down a very tall building at constant speed. There is vacuum in elevator. Suddenly the elevator cable snaps, sending the elevator into free fall. Being shocked, the girl lets go of the string. She is even more surprised to see

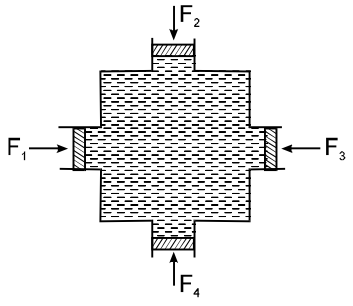
(1) the balloon rising

(2) the balloon floating downward

(3) the balloon remaining stationary

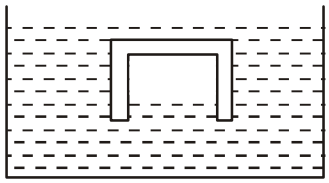
(4) the balloon bouncing slowly between the floor and the ceiling

30. In the figure shown water is filled in a symmetrical container. Four pistons of equal area A are used at the four opening to keep the water in equilibrium. Now an additional force F is applied at each piston. The increase in the pressure at the centre of the container due to this addition is



(1) $\frac{F}{A}$ (2) $\frac{2F}{A}$ (3) $\frac{4F}{A}$ (4) 0

31. An empty glass jar is submerged in tank of water with open mouth of the jar downwards, so that air inside the jar is trapped and cannot get out. As the jar is pushed down slowly, the magnitude of net buoyant force on the system of volume of gas trapped in the jar and on the jar :



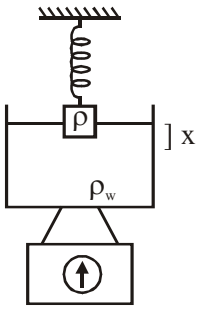
(1) increases

(2) decreases

(3) remains same

(4) Information is insufficient to draw inference.

32. A vessel filled with water is kept on a weighing pan and the scale adjusted to zero. A block of mass m and density ρ is suspended by a massless spring of spring constant K. This block is submerged into the water in the vessel. What is the reading of the scale. (volume submerged is V and density of water is ρ_w)



(1) $V\rho_w g$ (2) $V\rho g$

(3) $m_{vessel} + m_{water}$ (4) None of these

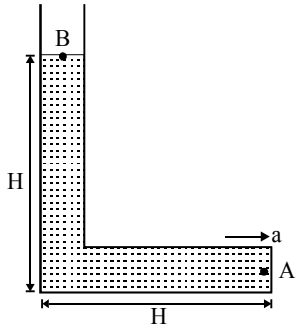
33. A necklace weight 50 g in air but it weights 46 g in water assume that copper is mixed with gold to prepare the necklace. Find how much copper is present in it.(Specific gravity of gold is 20 and that of copper is 10) :-

(1) 20 g (2) 10 g

(3) 30 g (4) 50 g

34. For the L shaped vessel shown in the figure, determine the value of acceleration a so that pressure at point A becomes equal to $\frac{p_0}{2}$.

[p_0 is the atmospheric pressure.]



(1) g

(2) $\frac{g}{2}+\frac{p_0}{2\rho H}$

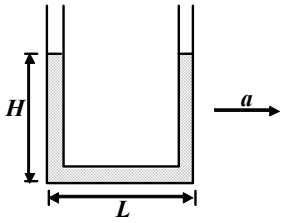
(3) $\frac{p_0}{2\rho H}+g$

(4) $\frac{3p_0}{2\rho H}+g$

35. A liquid stands at the plane level in the U-tube when at rest. If area of cross-section of both the limbs are equal, what will be the difference in heights *h* of the liquid in the two limbs of U-tube, when the system is given an acceleration *a* in horizontal direction towards right as shown?

(L = length of horizontal portion of tube,

H = initial height of liquid in both limbs)



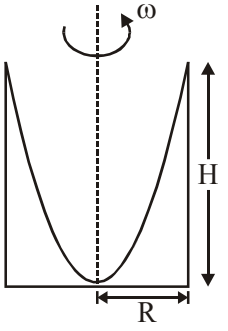
(1) $\frac{g}{a}\frac{L^2}{H}$

(2) $\frac{La}{g}$

(3) $\frac{L^2}{H}\frac{a}{g}$

(4) $\frac{Hg}{a}$

36. A cylinder of radius R and height H is filled with a liquid to an unknown height h when it is rotated at an unknown constant angular velocity ω, the base of the cylinder gets exposed when the liquid just starts spilling out as shown. Find angular speed ω of cylinder :-



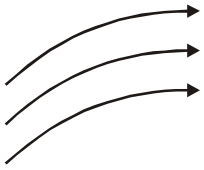
(1) $\frac{\sqrt{gH}}{R}$

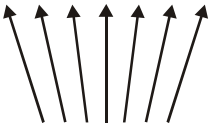
(2) $\frac{\sqrt{2gH}}{R}$

(3) $\frac{2\sqrt{gH}}{R}$

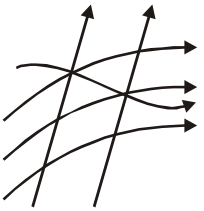
(4) None of these

37. Which of the following diagrams does not represent a streamline flow :-

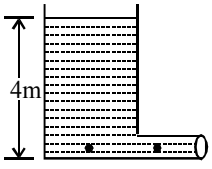
(1) 

(2) 

(3) 

(4) 

38. A vent tank of large cross-sectional area has a horizontal pipe 0.12 m in diameter at the bottom. This holds a liquid whose density is 1500 kg/m^3 to a height of 4.0 m. Assume the liquid is an ideal fluid in laminar flow. In figure, the velocity with which fluid flows out is



(1) $2\sqrt{5}$ m/s

(2) $\sqrt{5}$ m/s

(3) $4\sqrt{5}$ m/s

(4) $\sqrt{10}$ m/s

39. In the widest part of the horizontal pipe oil is flowing at a rate of 2 m/sec. Determine the speed of the flow of oil in the narrow part of the tube if the pressure difference in the broad and narrow parts of the pipe is 0.25 $\rho_{oil}g$.

(1) 9 m/s (2) 6 m/s

(3) 3 m/s (4) 1 m/s

40. A wind with speed 40 m/s blows parallel to the roof of a house. The area of the roof is 250 m^2. Assuming that the pressure inside the house is atmospheric pressure, the force exerted by the wind on the roof and the direction of the force will be :

(ρ_{air} = 1.2 kg/m^3)

(1) 4.8×10^5 N, upwards

(2) 2.4×10^5 N, upwards

(3) 2.4×10^5 N, downwards

(4) 4.8×10^5 N, downwards

41. A fully loaded boeing aircraft has a mass of 3.3×10^5kg. It's total wing area is 500m^2. It is in level flight with a speed of 960km/h. Estimate the pressure difference between the lower and upper surfaces of the wings.:-

(1) 6.5×10^3 N/m^2 (2) 12.5×10^3 N/m^2

(3) 3.25×10^3 N/m^2 (4) $2.5 \times 10^3$$N/m^2$

42. Water is being poured into a vessel at a constant rate ϕ m^3/s. There is a small aperture of cross sectional area "a" at the bottom of the vessel. The maximum level of water in the vessel is proportional to :-

(1) ϕ (2) ϕ^2 (3) 1/a (4) a

43. Water flows out of the hole on the side of a bucket and follows a parabolic path. If the bucket falls freely under gravity, ignoring air resistance, the water flow

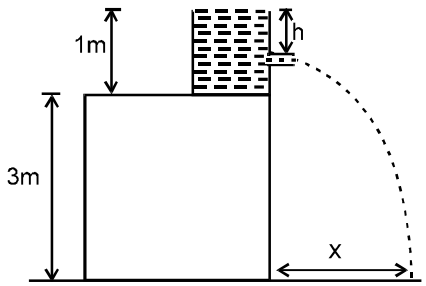
(1) follows a straight line path relative to the falling bucket

(2) follows a parabolic path relative to the falling bucket

(3) decreases but continues to flow

(4) stops

44. A water tank stands on the roof of a building as shown. Then the value of h for which the distance covered by the water 'x' is greatest is



(1) 0.5 m (2) 0.67 m

(3) 1 m (4) none of these

45. The graph between terminal velocity (along y-axis) and square of radius (along x-axis) of spherical body of density ρ allowed to fall through a fluid of density σ is a :-

(1) Straight line with positive slope

(2) Straight line with negative slope

(3) Straight line perpendicular to x-axis

(4) Straight line perpendicular to y-axis

46. A spherical solid ball of volume V is made of a material of density ρ_0. It is falling through a liquid of density ρ' ($\rho' < \rho_0$). 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 -

(1) $\sqrt{\frac{Vg(\rho_0 - \rho')}{k}}$

(2) $\frac{Vg\rho_0}{k}$

(3) $\sqrt{\frac{Vg\rho_0}{k}}$

(4) $\frac{V(\rho_0 - \rho')}{k}$

47. If two uniform spherical drops of a liquid having same mass, radius, and falling freely with a terminal velocity of $\sqrt[3]{16}$ m/s, coalesce to form a bigger drop, then the terminal velocity with which the bigger drop falls is :-

(1) 8 m/s (2) 4 m/s

(3) 10 m/s (4) None of these

48. Two large vertical parallel plates separated by a gap of d have a highly viscous liquid of density ρ and viscosity coefficient η, flowing steadily under gravity in the gap. The velocity gradient of flow near plates surface is :-

(1) $\frac{2\rho dg}{\eta}$ (2) $\frac{3\rho dg}{\eta}$

(3) $\frac{\rho dg}{3\eta}$ (4) $\frac{\rho dg}{2\eta}$

49. A solid sphere moves at a terminal velocity of 20 m/s in air at a place where g = 10 m/s^2 downwards. The sphere is taken in a hall, where g = 5 m/s^2 downwards having air of same viscosity and sphere is pushed down at a speed of 40 m/s. Then select incorrect statement :- [Neglect buoyancy of air]

(1) Its initial acceleration will be 15 m/s^2 downward.

(2) Its initial acceleration will be 15 m/s^2 upward

(3) The magnitude of acceleration will decrease as time passes and becomes zero after some time

(4) New terminal velocity of the solid sphere will be 10 m/s downwards

50. A solid sphere moves at a terminal velocity of 20 m/s in air at a place where g = 9.8 m/s^2. The sphere is taken in a gravity free hall having air at the same pressure and pushed down at a speed of 20 m/s. Then incorrect statement is :

(1) Its initial acceleration will be 9.8 m/s^2 downward

(2) Its initial acceleration will be 9.8 m/s^2 upward

(3) The magnitude of acceleration will decrease as the time passes

(4) It will eventually stop

51. A small sphere falls from rest in a viscous liquid. Due to friction heat is produced. What is the relation between the rate of production of heat and radius of the sphere at terminal velocity.

(1) $\frac{dQ}{dt} \propto r^2$ (2) $\frac{dQ}{dt} \propto r^5$

(3) $\frac{dQ}{dt} \propto r$ (4) None of these

52. Water flows in a streamline manner through a capillary tube of radius 'a'. The pressure difference being P and the rate of flow is Q. If the radius is reduced to $\frac{a}{2}$ and the pressure is increased to 2P, then the rate of flow becomes-

(1) 4 Q (2) Q/2 (3) Q **(4)** Q/8

53. A U-shaped wire is dipped in a soap solution and removed. The thin soap film formed between the wire and light slider supports a weight of 1.5×10^{-2} N (which includes the small weight of the slider) the length of the slider is 30 cm. What is the surface tension of the film:-

(1) 5×10^{-2} Nm^{-1}

(2) 2.5×10^{-2} Nm^{-1}

(3) 1.5×10^{-2} Nm^{-1}

(4) 3×10^{-2} Nm^{-1}

54. n number of water droplets, each of radius r, coalesce, to form a single drop of radius R. The rise in temperature dθ is (T = surface tension in $\frac{N}{m}$, ρ = density of water in $\frac{kg}{m^3}$, s = specific heat capacity of water in $\frac{cal}{kg/^\circ C}$, J = mechanical equivalent of heat in $\frac{J}{cal}$)

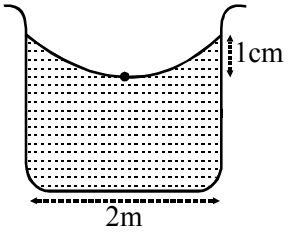
(1) $\frac{3T}{\rho s}\left(\frac{1}{r}-\frac{1}{R}\right)$

(2) $\frac{3T}{J\rho s}\left(\frac{1}{r}-\frac{1}{R}\right)$

(3) $\frac{3T}{\rho s}\left(\frac{1}{r}+\frac{1}{R}\right)$

(4) $\frac{3T}{J\rho s}\left(\frac{1}{r}+\frac{1}{R}\right)$

55. A container of width 2m is filled with a liquid. A thin wire of mass per unit length 10 g/m is gently placed over the liquid surface in the middle of the surface as shown in the figure. As a result, the liquid surface is depressed by a distance 1 cm. Determine the surface tension (in SI unit) of the liquid. Assume suitable approximation.



(1) 5 N/m (2) 8 N/m (3) 6N/m (4) 7 N/m

56. The grease deposited on a glass plate can be easily removed by cleaning the glass with hot water containing detergent powder, because the detergent powder :-

(1) Reduces the angle of contact between the solution and glass

(2) Increases the temperature of the solution

(3) Decrease the density of the solution

(4) Makes the angle of contact between solution and the glass to an obtuse angle

57. The properties of a surface molecules are different from those of the bulk liquid because the surface molecules :-

(i) are smaller than other molecules

(ii) acquire charge due to collision from air molecules

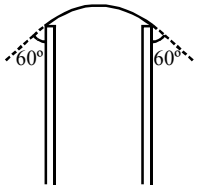
(iii) find different type of molecules in their range of influence

(iv) feel a net force in one direction

(1) (i), (ii) (2) (ii), (iii)

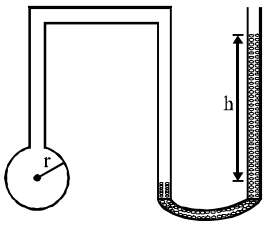
(3) (iii), (iv) (4) (i), (iv)

58. A soap bubble is being blown on a tube of radius 1 cm. The surface tension of the soap solution is 0.05 $\frac{N}{m}$ and the bubble makes an angle of 60^o with the tube as shown. The excess of pressure over the atmospheric pressure in the tube is :



(1) 5 Pa (2) 1 Pa (3) 10 Pa (4) 20 Pa

59. If the radius of the air-bubble on one side of tube is r and difference in height of liquid of density ρ in manometer is h, then surface tension of liquid used to make the bubble is :-



(1) $T = 2r\rho hg$ (2) $T = \frac{rh\rho g}{4}$

(3) $T = \frac{2\pi rh\rho g}{2}$ (4) $T = \frac{rh\rho g}{2}$

60. A capillary tube of radius 0.2 cm is dipped vertically in a beaker containing liquid. If the liquid rises to a height of 5 cm for which the angle of contact is 60°, then surface tension of the liquid is ($d = 1\ gm/cm^3$) :-

(1) 49 dynes/cm (2) 98 dyne/cm

(3) 490 dynes/cm (4) 980 dynes/cm

61. When a capillary tube is dipped into a liquid. The liquid neither rises nor falls in the capillary :-

(i) The surface tension of the liquid must be zero

(ii) The angle of contact must be 90^o

(iii) The surface tension may be zero

(iv) The angle of contact may be 90^o

(1) (i), (ii) (2) (iii), (iv)

(3) (ii), (iii) (4) (ii), (iv)

62. A 20 cm long capillary tube is dipped in water. The water rises up to 8 cm. If the entire arrangement is put in a freely falling elevator the length of water column in the capillary tube will be :-

(1) 8 cm (2) 6 cm

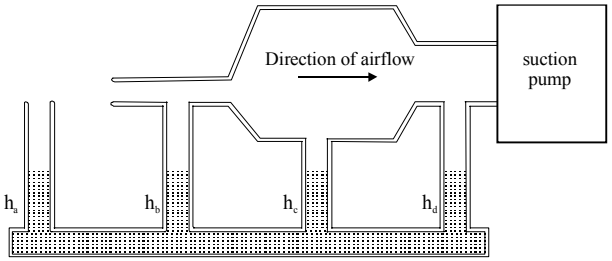
(3) 10 cm (4) 20 cm.

63. The free surface of oil in a tanker at rest is horizontal. If the tanker starts accelerating, the free surface will be tilted by an angle θ. If the acceleration is a ms^{-2} what will be value of θ ?

(1) $\theta = \tan^{-1}\left(\frac{a}{g}\right)$ (2) $\theta = \tan^{-1}\left(\frac{g}{a}\right)$

(3) $\theta = \tan^{-1}(a)$ (4) $\theta = \tan^{-1}(g)$

64. Rank in order, from highest to lowest, the liquid heights h_a to h_d. The air flow is from left to right. The liquid columns are not drawn to scale:-



(1) $h_a > h_b = h_d > h_c$
(2) $h_b = h_d > h_c > h_a$
(3) $h_d > h_c > h_b > h_a$
(4) $h_b > h_d > h_c > h_a$

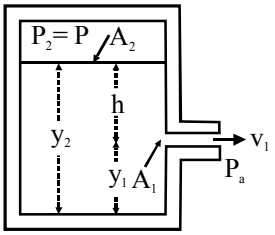
65. Consider a tank containing a liquid of density ρ with a small hole in its side at a height y_1 from the bottom. The air above the liquid, whose surface is at height y_2, is at pressure P. The velocity of fluid at A_1 is :-

(1) $\sqrt{2gh + 2(P - P_a)}$

(2) $\sqrt{2gh + (P - P_a)}$

(3) $\sqrt{2gh + \frac{2(P - P_a)}{\rho}}$

(4) $\sqrt{gh + \frac{(P - P_a)}{\rho}}$



ANSWER KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	2	3	3	4	4	3	4	1	1	3	3	4	3	3	1	2	3	2	1	3
Que.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	2	2	4	1	4	4	4	4	3	1	2	1	3	3	2	2	4	3	3	2
Que.	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Ans.	1	2	4	3	1	1	2	4	1	1	2	4	2	2	1	1	3	3	2	4
Que.	61	62	63	64	65															
Ans.	2	4	1	4	3															