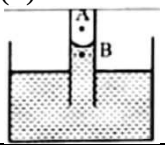
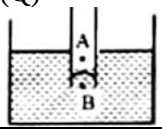
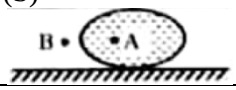
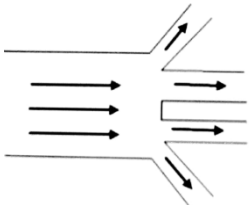
MECHANICAL PROPERTIES OF SOLID & FLUIDS

1. Capillary rise and shape of droplets on a plate due to surface tension are shown in column II.

Column I	Column II
(A) Adhesive forces is greater than cohesive forces	(P) 
(B) Cohesive forces is greater than adhesive forces	(Q) 
(C) Pressure at A > pressure at B	(R) A mercury drop is pressed between two parallel plates of glass 
(D) Pressure at B > Pressure at A	(S) 

(a) (A)→P; (B)→Q,R,S ; (C)→P,S; (D)→Q,R
(b) (A)→P,S; (B)→Q,R; (C)→P,S; (D)→Q,R
(c) (A)→R,S; (B)→Q,S; (C)→RS; (D)→Q,R
(d) (A)→Q,S; (B)→R,S; (C)→P,S; (D)→Q,R

2. Water is flowing through a channel that is 12 m wide with a speed of 0.75 m/s. The water then flows into four identical channels that have a width of 4.0m. The depth of the water does not change as it flows into the four channels. What is speed of the water in one of the smaller channels?



(a) 0.56 m/s (b) 2.3 m/s
(c) 0.25 m/s (d) 0.75 m/s

3. A liquid having area of free surface 'A' has an orifice at a depth 'h' with an area 'a' below liquid surface, then the velocity V of flow through the orifice is -

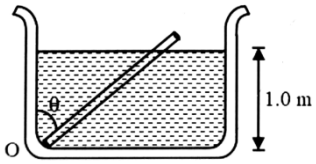
(a) $\sqrt{2gh}$ (b) $\sqrt{2gh}\sqrt{\frac{A^2}{A^2-a^2}}$

(c) $\sqrt{2gh}\sqrt{\frac{A}{A-a}}$ (d) None of these

4. A vessel contain oil (d = 0.8 g/cc) over mercury (d = 13.6 g/cc). A homogeneous sphere floats with half its volume immersed in mercury and the other half in oil. The density of the material of the sphere in g/cc is
(a) 3.3 (b) 6.4
(c) 7.2 (d) 12.8

5. Water from a tap emerges vertically downwards with an initial speed of 1.0 m/s. The cross sectional area of tap is 10^{-4} m^2. Assume that the pressure is constant throughout and that the flow is steady, the cross-sectional area of stream 0.15 m below the tap is:
(a) 5.0×10^{-4} m^2 (b) 1.0×10^{-4} m^2
(c) 5.0×10^{-5} m^2 (d) 2.0×10^{-5} m^2

6. A uniform rod of length 2.0 m specific gravity 0.5 and mass 2 kg is hinged atone end to the bottom of a tank of water (specific gravity = 1.0) filled upto a height of 1.0 m as shown in figure. Taking the case $\theta \neq 0°$ the force exerted by the hinge on the rod is: ($g = 10$ m/s^2)-



(a) 10.2 N upwards (b) 4.2 N downwards
(c) 8.3 N downwards (d) 6.2 N upwards

7. A beaker containing water is placed on the platform of a spring balance. The balance reads 1.5 kg. A stone of mass 0.5 kg and density 500 kg/m^3 is completely immersed in water without touching the walls of beaker. Now the balance reading will be -
(a) 2 kg (b) 1 kg
(c) 2.5 kg (d) 3 kg

8. Water is flowing in a horizontal pipe of non-uniform cross - section. At the most contracted place of the pipe -
(a) Velocity of water will be maximum and pressure minimum
(b) Pressure of water will be maximum and velocity minimum
(c) Both pressure and velocity of water will be maximum
(d) Both pressure and velocity of water will be minimum

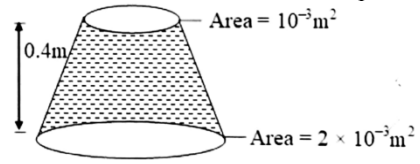
9. A tank has an orifice near its bottom. The volume of the liquid I flowing per second out of the orifice does not depend upon -
(a) Area of the orifice
(b) Height of the liquid level above the orifice
(c) Density of liquid
(d) Acceleration due to gravity

10. Water enters a horizontal pipe of non- uniform cross-section with a velocity of 0.5 m/s and leaves the other end with a velocity of 0.7 m/s. The pressure of water at the first end is 10^3 N/m^2. Calculate pressure at the other end. (Density of water = 1.0×10^3 kg/m^3) -
(a) 980 N/m^2 (b) 880 N/m^2

(c) 800 N/m (d) None of these

11. A 20 cm long capillary tube is dipped in water. The water rises upto 8 cm. If the entire arrangement is put in a freely falling elevator the length of water column in the capillary tube will be -
(a) 8 cm (b) 10 cm
(c) 4 cm (d) 20 cm

12. A uniformly tapering vessel shown in Fig. is filled with liquid of density 900 kg/m^3. The force that acts on the base of the vessel due to liquid is (take g = 10 m/s^2)-

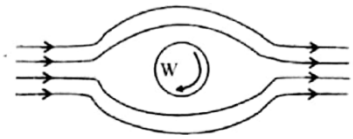


(a) 3.6 N (b) 7.2 N
(c) 9.0 N (d) 12.6 N

13. A body is just floating in a liquid (their densities are equal). If the body is slightly pressed down and released it will -
(a) start oscillating
(b) sink to the bottom
(c) come back to the same position immediately
(d) come back to the same position slowly

14. An ice block floats in a liquid whose density is less than water. A part of block is outside the liquid. When whole of ice has melted, the liquid level will -
(a) rise
(b) go down
(c) Remain same
(d) first rise then go down

15. **Statement-1:** As wind flows left to right and ball is spinned as shown, there will be a lift of the ball.



Statement-2: Decreased velocity of air below the ball, increases the pressure more than that above the ball.
(a) Both Statements (1) and (2) are true
(b) Statement (1) is true but statement (2) is false
(c) Statement (1) is false but statement (2) is true
(d) Both Statements (1) and (2) are False

16. A cubical block is floating in a liquid with half of its volume immersed in the liquid. When the whole system accelerates upwards with a net acceleration of g/4, the fraction of volume immersed in the liquid will be -
(a) 1/2 (b) 1/4
(c) 3/4 (d) 3/8

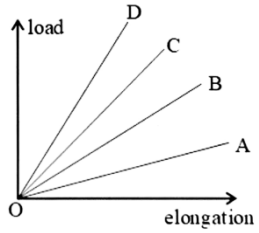
17. Two wires of copper are given. Wire A: length *l* and radius r, wire B: length *l* and radius 2r. If Young's modulus for wire A is Y_A and for wire B is Y_B. Then -
(a) $Y_A = 4Y_B$ (b) $4Y_a = Y_B$
(c) $Y_A = Y_B$ (d) $Y_A = 2Y_b$

18. A wire suspended vertically from one of its ends is stretched by attaching a weight of 200 N to the lower end. The weight stretches the wire by 1 mm. Then the elastic energy stored in the wire -
(a) 0.1J (b) 0.2 J
(c) 10 J (d) 20 J

19. A ball falling in a lake of 200 m shows a decrease of 0.1% in its volume. The Bulk modulus of elasticity of the material of the ball is - (take g =10m/s^2)
(a) 10^9 N/m (b) 2×10^9N/m^2
(c) 3×10^9 N/m^2 (d) 4×10^9N/m^2

20. A wire of length L and radius r is fixed at one end and force F applied to the other end produces an extension Y. The extension produced in another wire of the same material of length 2L and radius 2r by a force of 2F is-
(a) Y (b) 2Y
(c) Y/2 (d) 4/Y

21. The load versus elongation graph for four wires of the same material is shown in figure. The thinnest wire is represent by the line-



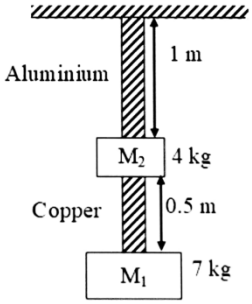
(a) OC (b) OD
(c) OA (d) OB

22. If two wires of same length *l* and area of cross section A with Young modulus Y and 2Y connect in series and one end is fixed or roof and other end with mass m. Make simple harmonic motion, then the time period is-
(a) $2\pi\sqrt{\frac{ml}{YA}}$ (b) $2\pi\sqrt{\frac{ml}{3YA}}$
(c) $2\pi\sqrt{\frac{3ml}{2YA}}$ (d) $2\pi\sqrt{\frac{ml}{2YA}}$

23. Value of Y of a wire depends upon -
(a) length of wire and change in length of wire
(b) force and area of wire
(c) (a) and (b) are both
(d) None

24. A metal wire is first stretched beyond its elastic limit and then released. It -
(a) Loses its elastic property completely and it will not contract
(b) Will contract to its original length
(c) Will contract to its length at elastic limit
(d) Will contract but final length will be greater than original length

25. A copper wire of 1.4 mm diameter and an aluminum wire of 1 mm diameter are shown in the figure. The ratio of the elongation in Aluminum wire to copper wire is:
[$Y_{Cu} = 11 \times 10^{10}$ N/m^2, $Y_{Al} = 7 \times 10^{10}$ N/m^2]



(a) 19.6 (b) 9.8
(c) 4.9 (d) 21.6

26. If two soap bubbles of different radii are connected by a tube,
(a) Air flows from the bigger bubble to the smaller bubble till the sizes become equal
(b) Air flows from bigger bubble to the smaller bubble till the sizes air interchanged
(c) Air flows from the smaller bubble to the bigger
(d) There is no flow of air

27. The surface tension of a liquid is 5 N/m. If a film is held on a ring of area 0.02 m^2, its total surface energy is about-
(a) 5×10^{-2} J (b) 2.5×10^{-2} J
(c) 2×10^{-1} J (d) 3×10^{-1} J

28. Water rises to a height of 16.3 cm in a capillary of height 18 cm. If the tube is cut at a height of 12 cm, then-
(a) water will come as a fountain from the capillary
(b) water will stay at a height of 12 cm in capillary
(c) the height of the water in the tube will be 10.3 cm
(d) water will flow down the sides of the capillary tube

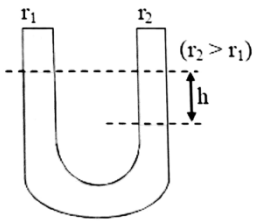
29. When detergent is added to water; surface tension of solution -
(a) remain same as that of detergent
(b) is reduced
(c) increased
(d) may decrease or increase depending upon type of detergent

30. W is the work done in forming a bubble of radius r, the work done in forming a bubble of radius 2r will be -
(a) 4W (b) 3W
(c) 2W (d) W

31. Several spherical drops of a liquid each of radius r coalesce to form a single drop of radius R. If T is the surface tension, theft the energy liberated will be -
(a) $4\pi R^3 T\left(\frac{1}{r}-\frac{1}{R}\right)$ (b) $2\pi R^3 T\left(\frac{1}{r}-\frac{1}{R}\right)$
(c) $\frac{4}{3}\pi R^3 T\left(\frac{1}{r}-\frac{1}{R}\right)$ (d) $2\pi R^3 T\left(\frac{1}{R}-\frac{1}{r}\right)$

32. Two soap bubbles of radii 3 cm and 4 cm are kept in contact, then the radius of curvature of common surface will be -
(a) 5 cm (b) 7 cm
(c) 9 cm (d) 12 cm

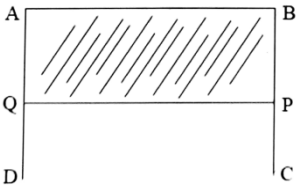
33. In a U-tube the radii of two columns are respectively r_1 and r_2 and if a liquid of density d filled in it has level difference of h then the surface tension of the liquid is -



(a) $T = \frac{hdg}{r_2-r_1}$ (b) $T = \frac{(r_2-r_1)hdg}{2}$
(c) $T = \frac{(r_2+r_1)hdg}{2}$ (d) $T = \frac{hdg}{2}\frac{(r_1r_2)}{r_2-r_1}$

34. A square plate of 0.1 m side moves parallel to a second, plate with a velocity of 0.1 m/s, both plates being immersed in water. If the viscous force is 0.002 N and the coefficient of viscosity is 0.01 poise, distance between the plates in meter is-
(a) 0.1 (b) 0.05
(c) 0.005 (d) 0.0005

35. A soap films formed over a frame ABCD as shown in figure. Wire PQ can slide without friction surface tension for soap is 0.045 J/m^2 and density of material of wire is 8.96×10^3 kg/m^3. If wire PQ is in equilibrium then its diameter shall be -



(a) 0.6 mm (b) 0.6 cm
(c) 1.2mm (d) 1.2 cm

36. A capillary tube of radius R is immersed in water and water rises in it to a height H. Mass of the water in the capillary tube is M. If the radius of the tube is

doubled, mass of the water that will rise in the capillary tub will be -
(a) M (b) 2M (c) M/2 (d) 4M

37. When a capillary tube is immersed vertically in mercury, the level of mercury in the capillary is observed to be depressed. This is due to -
(a) Surface tension (b) Viscosity
(c) Adhesive force is more than cohesive force
(d) Cohesive force is equal to the adhesive force

38. If a liquid neither rises nor depresses in a capillary, then it means that
(a) Angle of contact is 0°
(b) Angle of contact may be 90°
(c) Surface tension of the liquid must be zero
(d) None of these

39. An air bubble of radius 1mm is formed inside water at a depth 10m below free surface (where air pressure is 10^5 N/m^2). The pressure inside the bubble is -
(Surface tension of water = 7×10^{-2}, N/m)
(a) 2.28×10^5 N/m^2 (b) 2.0028×10^5 N/m^2
(c) 2.14×10^5 N/m^2 (d) 2.0014×10^5 N/m^2

40. A wide jar is filled with glycerin having specific gravity 1.26, in this jar a steel ball of radius 0.25 cm has been dropped. After some time it has observed that ball is taking equal interval of time 1.8 sec to cover equal successive distances of 20 cm. The viscosity of glycerin in N s/m^2 would be [ρ_{steal} = 7.8×10^3 kg/m^3, g = 9.8 m/s^2]-
(a) 0.802 (b) 1.67
(c) 0.76 (d) 0.963

41. A solid ball of density ρ_1 and radius r falls vertically through a liquid of density ρ_2. Assume that the viscous force acting on the ball is F = krv, where k is a constant and v its velocity. What is the terminal velocity of the ball?
(a) $\frac{4\pi r^2(\rho_1-\rho_2)g}{3k}$ (b) $\frac{2\pi r(\rho_1-\rho_2)}{3k}$
(c) $\frac{2\pi g(\rho_1-\rho_2)}{3gr^2k}$ (d) none of these

42. A small lead ball is falling freely in a viscous liquid. The velocity of the ball -
(a) goes on increasing (b) goes on decreasing
(c) remains constant
(d) first increases and then becomes constant

43. There is a 1 mm thick layer of oil between a flat plate of area 10^{-2} m^2 and a big plate. How much force is required to move the plate with a velocity of 1.5 cm/s? The coefficient of viscosity of oil is 1 poise -
(a) 1.5×10^{-3}N (b) 1.3×10^{-5}N
(c) 1.5×10^{-2}N (d) 1.5×10^2N

44. If the terminal speed of a sphere of gold (density = 19.5 kg/m^3) is 0.2 m/s in a viscous liquid (density = 1.5 kg/m^3), find the terminal speed of a sphere of silver (density = 10.5 kg/m^3) of the same size in the same liquid-.
(a) 0.1 m/s (b) 0.2 m/s
(c) 0.4 m/s (d) 0.133 m/s

45. Two spheres A and B fall through the same viscous fluid. A and B have the same density and B has the larger radius-
(a) A has the larger terminal velocity
(b) A and B have the same terminal velocity
(c) B has the larger terminal velocity
(d) Insufficient information is given to reach a conclusion.

46. In steel, the Young's modulus and the strain at the breaking point are 2×10^{11}Nm^{-2} and 0.15 respectively. The stress at the break point for steel is
(a) 1.33×10^{11}Nm^{-2} (b) 1.33×10^{12} Nm^{-2}
(c) 2×10^{10} Nm^{-2} (d) 3×10^{10} Nm^{-2}

47. In a wire stretched by hanging a weight from its end, the elastic potential energy per unit volume in terms of longitudinal strain a and modulus of elasticity Y is
(a) $\frac{Y\sigma^2}{2}$ (b) $\frac{Y\sigma}{2}$
(c) $\frac{2Y\sigma^2}{2}$ (d) $\frac{Y^2\sigma}{2}$

48. Water flows through a vertical tube of variable cross-section. The area of cross-section at A and B are 6 and 3mm^2 respectively. If 12 cc of water enters per second through A, find the pressure difference $p_A - p_B$ (g = 10 ms^{-2}). The separation between cross- section at A and B is 100 cm
(a) 1.6×10^5 dyne cm^{-2} (b) 2.29×10^5 dyne cm^{-2}
(c) 5.9×10^5 dyne cm^{-2} (d) 3.9×10^5 dyne cm^{-2}

49. An inverted bell lying at the bottom of a lake 47.6 m deep has 50 cm^3 of air trapped in it. The ball is brought to the surface of the lake. The volume of the trapped air will be (atmospheric pressure = 70 cm of and density of Hg = 13.6 g/c m^3)
(a) 350 cm^3 (b) 300 cm^3
(c) 250 cm^3 (d) 22 cm^3

50. A large tank is filled with water to 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 $\frac{H}{\eta}$ ($\eta > 1$) and it takes T_2 time to take out the rest of water. If $T_1 = T_2$, then the value of η is
(a) 2 (b) 3 (c) 4 (d) $2\sqrt{2}$