CLASS – 11

WORKSHEET- MECHANICAL PROPERTIES OF FLUIDS

A. FLUID AND PASCAL'S LAW

(1 Mark Questions)

1. Pressure at a point inside a liquid does not depend on
   (a) the nature of the liquid (b) shape of the container
   (c) the depth of point below the surface of the liquid
   (d) acceleration due to gravity at that point

2. The dams of water reservoir are made thick near the bottom. Why?

   _____
   _____

3. The blood pressure in human is greater at the feet than at the brain. Why?

   _____
   _____

4. It is painful to walk barefooted on the ground with edged pebbles. Why?

   _____
   _____

5. What do you mean by average pressure (P_{av})?

   _____
   _____

6. Why deep water runs deep still?

(2 Marks Questions)

7. Why air bubbles in a liquid moves in upward direction?

8. Why is it difficult to stop bleeding from a cut in human body at high altitudes?

9. On what principles working of hydraulic brakes are based? State the principles.

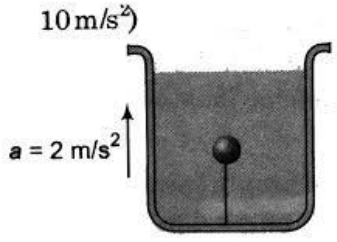
10. A hydraulic automobile lift is designed to lift cars with a maximum mass of 3000 kg. The area of cross-section of the piston carrying the load is 425 cm^2. What maximum pressure would the smaller piston have to bear? [Ans. 6.92×10^5 N/m^2]

(3 Marks Questions)

11. The drop of liquid of density ρ is floating with $1/4^{th}$ inside the liquid A of density ρ_1 and remaining in the liquid B of density ρ. Then, find the relation between the densities of liquid A and B.

12. Explain why:
(a) A balloon filled with helium does not rise in air indefinitely but halts after a certain height (Neglect winds).
(b) The force required by man to raise his limbs immersed in water is smaller than the force for the same movement in air.

13. A solid sphere of mass m = 2kg and density of 0.5×10^3 kg/m^3 is held stationary relative to a tank filled with water as shown in figure. The tank is accelerating vertically upward with acceleration $2m/s^2$.

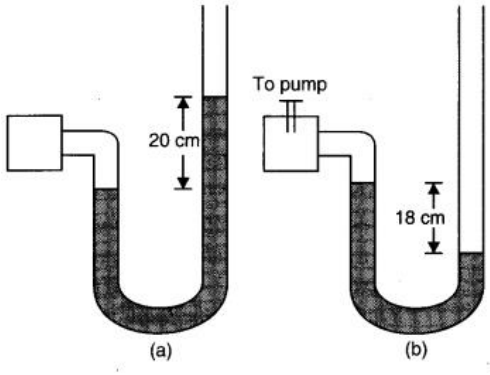


(a) Calculate the tension in the thread connecting the sphere and the bottom of the tank.
(b) If the thread snaps, calculate the acceleration of the sphere with respect to the tank (density of water is $\rho = 1000$ kg/m^3 and $g = 10$ m/s^2).

14. A U-tube contains water and methylated spirit separated by mercury. The mercury columns in the two arms are in level with 10.0 cm of water in one arm and 12.5 cm of spirit in the other. What is the specific gravity of the spirit? [Ans. 0.8]

15. In the previous Qs if 15.0 cm of water and spirit each are further poured into the respective arms of the tube, what is the difference in the levels of mercury of the two arms? Specific gravity of mercury = 13.6. [Ans. 0.221 cm]

16. The manometer reads the pressure of a gas in an enclosure as shown in figure. When some of the gas is removed by a pump, the manometer reads as in figure (b).



The liquid used in the manometers is mercury and the atmospheric pressure is 76 cm of mercury.

(i) Give the absolute and gauge pressure of the gas in the enclosure for cases (a) and (b) in units of cm of mercury.

(ii) How would the levels change in case (b) if 13.6cm of water (immiscible with mercury) are poured into the right limb of the manometer? (Ignore the small change in volume of the gas). [Ans. (i) 18cm of Hg (ii) 1 cm]

(5 Marks Questions)

17. (a) Derive an expression for the pressure exerted by a liquid column of height h.

(b) A column of water 40cm high supports a 30cm column of an unknown liquid. What is the density of the liquid?

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B. FLUID DYNAMICS

(1 Mark Questions)

1. Why are straws used to suck soft drinks?

2. Steamline flow is more likely for liquids with

(a) high density and high viscosity (b) low density and low viscosity

(c) high density and low viscosity (d) low density and high viscosity

3. When the flow parameters of any given instant remain same at every point, then flow is said to be

(a) laminar (b) steady state (c) turbulent (d) quasi-static

4. An ideal flow of any fluid must satisfy
   (a) Pascal law (b) Stoke's law
   (c) Continuity equation (d) Bernoulli's theorem

5. When does the flow of liquid become turbulent?

6. Why does velocity increase when water flowing in a broad pipe enters a narrow pipe?

7. Dynamic lift due to spinning is
   (a) Magnus effect (b) Doppler effect (c) Pascal effect (d) Toricelli's effect

8. Bernoulli's equation for steady, non-viscous incompressible flow expresses the
   (a) conservation of linear momentum (b) conservation of angular momentum
   (c) conservation of energy (d) conservation of mass

9. Applications of Bernoulli's theorem can be seen in
   (a) dynamic lift of aeroplane (b) hydraulic press
   (c) helicopter (d) none of these

10. A cylinder of height 20m is completely filled with water. The velocity of efflux of water through a hole on the side wall of the cylinder near its bottom is (take $g = 10\ ms^{-2}$)
    (a) $10\ ms^{-1}$ (b) $20\ ms^{-1}$ (c) $25.5\ ms^{-1}$ (d) $5\ ms^{-1}$

11. When air is blown between two balls suspended close to each other they are attracted towards each other. Why?

12. Why two ships moving in parallel directions close to each other get attracted?

13. Does it matter if one use gauge pressure instead of absolute pressure in applying Bernoulli's equation?

(2 Marks Questions)

14. What is the difference between steamline and turbulent flow?

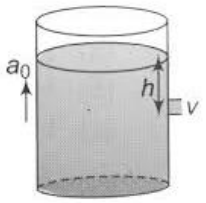
15. Explain, why when we try to close a water tap with our fingers, fast jets of water gush through the openings between our fingers.

16. The steam of water flowing at high speed from a garden hose pipe tends to spread like a fountain when held vertically up, but tends to narrow down when held vertically down. Explain how.

17. Explain why, to keep a piece of paper horizontal you should blow over, not under it.

18. Mention any three applications of Bernoullis principle.

19. For the area a of the hole is much lesser than the area of the base of a vessel of liquid, find velocity of efflux v of the liquid if vessel is accelerating as shown in figure. (a_0 = vertical acceleration)



20. Why we cannot remove a filter paper from a funnel by blowing air into narrow end?

21. In streamline flow, water entering a pipe having diameter of 2cm and the speed of water is 1.0 m/s. Eventually, the pipe tapers to a diameter of 1cm. Calculate the speed of water where diameter of pipe is 1cm.

22. Can Bernoulli's equation be used to describe the flow of water through a rapid in river? Explain.

(3 Marks Questions)

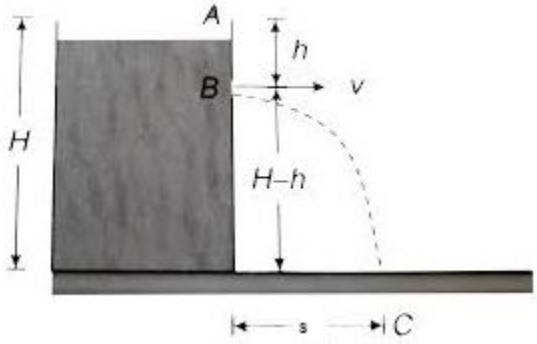
23. State Pascal's law of fluid pressure. Explain the working of hydraulic lift with suitable diagram.

24. State and prove equation of continuity for fluids.

25. The cylindrical tube of spray pump has a cross section of 8.0 cm^2 on one end of which has 40 fine holes each of diameter 1.0mm. If the flow of liquid inside the tube is 1.5m min^{-1}, what is the speed of ejection of the liquid through the holes?

26. Find the velocity of efflux of water from an orifice near the bottom of a tank in which pressure is 500 gf/sq cm above atmosphere.

27. Water stands at a depth H in a tank whose side walls are vertical as shown in the figure. A hole is made on one side of the walls at a depth h below the water surface.



(a) At what distance s from the foot of the wall does the emerging stream of water strike the floor?
(b) For what value of h this range is maximum?

28. Calculate the rate of flow of glycerine of density 1.25×10^3 kg m^{-3} through the conical section of pipe if the radii of its ends are 0.1m and 0.04m and pressure drop across its length is 10 Nm^{-3}.

29. In a test experiment on a model aero-plane in a wind tunnel, the flow speed on the upper and lower surfaces of the wing are 70 ms^{-1} and 63 ms^{-1} respectively. What is the lift of the wing if its area is 2.5 m^2? Density of air = 13 kg m^{-3}. [Ans. 1512.9 N]

(5 Marks Questions)

30. What is laminar flow of a liquid? Distinguish between the velocity profiles of non viscous and viscous liquids?

31. The bottom of a cylindrical vessel line has a hole of diameter d. The diameter of the vessel is D. Find the velocity with which the water level in the vessel drops in terms of the height h of this level.

32. State and Proof Bernoulli's theorem.

C. VISCOSITY

(1 Mark Questions)

1. With increase in temperature the viscosity of
   (a) liquids increases and of gases decreases (b) liquids decreases and of gases increases
   (c) both liquids and gases increases (d) both liquids and gases decreases
2. After terminal velocity is reached, the acceleration of a body falling through a viscous fluid is
   (a) zero (b) equal to g (c) less than g (d) more than g

3. Two balls A and B have radii in the ratio 1:4. What will be the ratio of their terminal velocities in a liquid?

4. Is viscosity a vector?

5. Which fall faster a big raindrops or small raindrops and why?

6. Define viscosity.

7. Define the coefficient of viscosity of a liquid.

8. What is the net weight of a body when it falls with terminal velocity through a viscous medium?

9. The pressure is increased on a gas, then what would be its effect on the viscosity?

(2 Marks Questions)

10. A small metal sphere of radius a is falling with a velocity v through vertical column of a viscous liquid. If the coefficient of viscosity of the liquid is η, then find an opposing force on the sphere.

11. What is kinetic viscosity?

12. What is Reynolds number?

13. What is the importance of Reynolds number?

(3 Marks Questions)

14. State and prove Toricelli's theorem.

15. Define terminal velocity. Derive an expression for it.

16. Show that Reynolds number represents the ratio of the intertial force per unit area to the viscous force per unit area.

(5 Marks Questions)

17. Explain how does a body attain a terminal velocity when it is dropped from rest in a viscous medium. Derive an expression for the terminal velocity of a small spherical body falling through a viscous medium.

D. SURFACE TENSION

(1 Mark Questions)

1. Why is it easier to swim in sea than in the river water?

2. For a surface molecule,
   (a) the net surface on it is non-zero (b) the net force on it is zero
   (c) there is net downward force (d) there is net upward force

3. Angle of contact of a liquid with a solid depends on
   (a) solid only (b) liquid only
   (c) both on solid and liquid (d) orientation of the solid surface in liquid

4. Which of the following statements is not true about surface tension?

(a) A small liquid drop takes spherical shape due to surface tension
(b) Surface tension is a vector quantity
(c) Surface tension of liquid is a molecular phenomenon
(d) Surface tension of liquid depends on length but not on the area

5. A rough sea can be calmed by pouring oil on the surface of sea. Explain

6. A 20cm capillary tube is dipped in water. The water rises upto 8cm. If the entire arrangement is put in a freely falling elevator, what will be the length of water column in the capillary tube?

7. If a capillary tube is immersed at first in cold water and then in hot water, the height of capillary is smaller in second case. Why?

8. Water rises in a capillary tube, whereas mercury falls in the same tube. Why?

9. Why are raindrops spherical?

10. Why the molecules of a liquid lying near the free surface possess extra energy?

11. What makes rain coats water proof?

12. What is meant by term molecular range?

13. What is the value of surface tension at critical temperature?

14. What is capillarity?

15. How is the rise of liquid affected, if the top of the capillary tube is closed?

16. Name the material in which capillary height will descend instead of rising.

17. Two soap bubbles have radii in the ratio 2:1. Find the ratio of the work done in blowing these bubbles.

18. What is the effect of temperature on surface tension?

(2 Marks Questions)

19. Calculate the energy evolved when 8 droplets of water (surface tension 0.072 nm^{-1}) of radius ½ mm each combine into one.

20. Mercury has an angle of contact equal to 140° with soda lime glass. A narrow tube of radius 1.00mm made of this glass is dipped in a through containing mercury. By what amount does the mercury dip down in the tube relative to the liquid surface outside? Surface tension of mercury at the temperature of experiment is 0.465 N/m. Density of mercury = 13.6×10^3 kg/m^3.

21. The excess pressure inside a soap bubble is thrice the excess pressure inside a second soap bubble. What is the ratio between the volume of the first and the second bubble?

22. The surface tension and vapour pressure of water at 20°C is 7.28×10^{-2} Nm^{-1} and 2.33×10^3Pa respectively. What is the radius of the smallest spherical water droplet which can form without evaporating at 20°C?

(3 Marks Questions)

23. The narrow bores of diameters 3.0mm and 6.0mm are joined together to form a U shaped tube open at both ends. If U tube contains water, what is the difference in its levels in the two limbs of the tube? Surface tension of water is 7.3×10^{-2} Nm^{-1}. Take the angle of contact to be zero, and density of water to be 1.0×10^3 kg m^{-3} and g = 9.8 m/s^2.

24. Three capillaries of internal radii 2r, 3r and 4r all of eh same length are joined end to end. A liquid passes through the combination and the pressure difference across this combination is 20.2 cm of mercury. What is the pressure difference across the capillary of internal radius 2r?

25. Two soap bubbles of radii a and b combine to form a single bubble of radius c. If P is the external pressure, then find the surface tension of the soap solution.

26. Derive an expression for the pressure difference across the soap bubble.

(5 Marks Questions)

27. Derive the ascent formula for rise of liquid in capillary tube. What will happen, if the length of the capillary tube is smaller than the height to which the liquid rises. Explain.

28. Define surface tension and surface energy. Obtain a relation between them.

29. (i) What is the phenomenon of capillarity?
(ii) Derive an expression for the rise of the liquid in a capillary tube.
(iii) What will happen if length of the capillary tube is smaller than the height to which the liquid rest? Explain briefly.

30. (a) If a capillary tube is immersed first in cold water and then in hot water, in which case height of water in the capillary tube is more? Give reason to support your answer.
(b) Two soap bubbles of unequal sizes are blown at the ends of a capillary tube. Which one will grow at the expense of other? Give reason for your answer.

31. Figure shows a thin liquid film supporting a small weight = 4.5×10^{-2} N. What is the weight supported by a film of the same liquid at the same temperature in figures? Explain your answers physically.