**CLASS – 11**

**WORKSHEET- MECHANICAL PROPERTIES OF FLUIDS**

**(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. Why is it easier to swim in sea than in the river water?
   _____
   _____

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

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

5. Why are straws used to suck soft drinks?
   _____
   _____

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

7. What do you mean by average pressure ($P_{av}$)?
   _____
   _____

8. 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

9. 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

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

11. When does the flow of liquid become turbulent?
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_____

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

13. Why deep water runs deep still?
_____
_____

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

15. 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

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

17. 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) $5\ ms^{-1}$

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

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

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

_____

_____

21. 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

22. 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

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

_____

_____

24. Is viscosity a vector?

_____

_____

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

_____

_____

26. Define viscosity.

_____

_____

27. Define the coefficient of viscosity of a liquid.

_____

_____

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

_____

_____

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

_____
_____

30. 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

31. 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

32. 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

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

34. 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?
_____
_____

35. 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?
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_____

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

37. Why are raindrops spherical?
_____
_____

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

_____
_____

39. What makes rain coats water proof?
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40. What is meant by term molecular range?
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_____

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

42. What is capillarity?
_____
_____

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

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

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

46. What is the effect of temperature on surface tension?
_____
_____

47. Fill in the blanks using the word(s) from the list appended with each statement:
(i) Surface tension of liquids generally _____ with temperatures (increases/decreases).
(ii) Viscosity of gases _____ with temperature, whereas viscosity of liquids _____ with temperature (increases/decreases).

(iii) For solids with elastic modulus of rigidity, the shearing force is proportional to _____ while for fluids it is proportional to _____ (shear strain/ rate of shear strain).
(iv) For a fluid in steady flow, the increase in flow spread at a construction follows from _____ while the decrease of pressure there follows from _____ (conservation of mass/ Bernoulli's principle).
(v) For a model of a plane in a wind tunnel, turbulence occurs at a _____ speed than the critical speed for turbulence for an actual plane (greater/smaller).

**(2 marks Questions)**

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

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_____
_____
_____

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

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_____
_____
_____

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

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_____
_____
_____

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

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_____
_____
_____

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

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_____

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53. 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.

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

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_____
_____
_____

55. Mention any three applications of Bernoullis principle.

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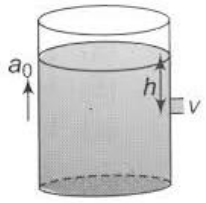
56. For the area a of the hole is much lesser than the area of the base of a vessel of liquid, find velocity of efflux v of the liquid if vessel is accelerating as shown in figure. ($a_0$ = vertical acceleration)




_____
_____
_____
_____

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

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_____
_____
_____

58. 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.

59. 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.

60. What is kinetic viscosity?

61. What is Reynolds number?

62. What is the importance of Reynolds number?

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

64. 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 = $13.6\times10^3$ kg/m$^3$.

65. 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?

66. The surface tension and vapour pressure of water at 20°C is $7.28\times10^{-2}$ Nm$^{-1}$ and $2.33\times10^3$Pa respectively. What is the radius of the smallest spherical water droplet which can form without evaporating at 20°C?

67. A 50kg girl wearing high heel shoes balances on a single heel. The heel is circular with a diameter 1.0cm. What is the pressure exerted by the heel on the horizontal floor?

[Ans. $6.2\times10^6$ Pa]

68. Toricelli's barometer used mercury, Pascal duplicated it using French wine of density 984. Determine the height of the wine column for normal atmospheric pressure.

**(3 marks Questions)**

69. The drop of liquid of density $\rho$ is floating with $1/4^{th}$ inside the liquid A of density $\rho_1$ and remaining in the liquid B of density $\rho$. Then, find the relation between the densities of liquid A and B.

70. 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.

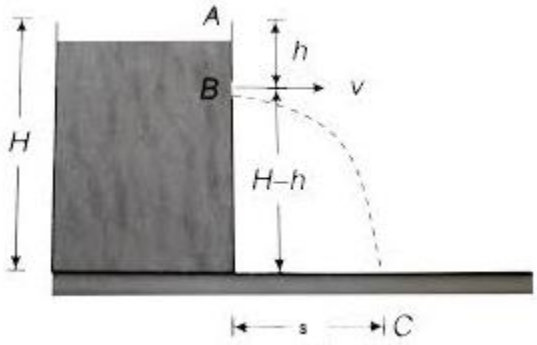
71. State Pascal's law of fluid pressure. Explain the working of hydraulic lift with suitable diagram.

72. State and prove equation of continuity for fluids.

73. 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?

74. 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.

75. 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.

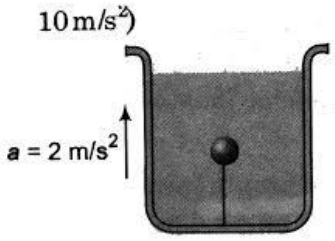


(a) At what distance s from the foot of the wall does the emerging stream of water strike the floor?
(b) For what value of h this range is maximum?

76. State and prove Toricelli's theorem.

77. Calculate the rate of flow of glycerine of density $1.25\times10^3$ kg $m^{-3}$ through the conical section of pipe if the radii of its ends are 0.1m and 0.04m and pressure dropacross its length is 10 $Nm^{-3}$.

78. A solid sphere of mass m = 2kg and density of $0.5\times10^3$ 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 $g = 10\ m/s^2$).

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

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

81. 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 $7.3\times10^{-2}$ $Nm^{-1}$. Take the angle of contact to be zero, and density of water to be $1.0\times10^{3}$ kg $m^{-3}$ and g = 9.8 $m/s^2$.

82. 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?

83. 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.

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

85. A vertical off-shore structure is built to withstands a maximum stress of $10^9$ Pa. Is the structure suitable for putting up on top of an oil well in Bombay high? Take the depth of the sea to be roughly 3km and ignore ocean currents.

86. 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. $6.92\times10^5$ $N/m^2$]

87. 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]

88. 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]

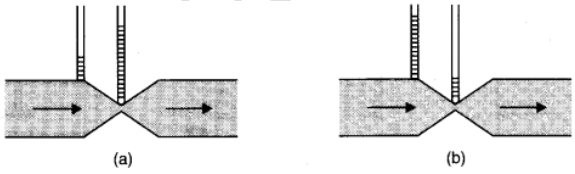
89. Can Bernoulli's equation be used to describe the flow of water through a rapid in river? Explain.

90. Does it matter if one uses gauge instead of absolute pressures in applying Bernoulli's equation? Explain.

91. Glycerin flows steadily through a horizontal tube of length 1.5m and radius 1.0cm. If the amount of glycerin collected per second at one end is $4.0\times10^{-3}$ $kgs^{-1}$. , What is the pressure difference between the two ends of the tube? Density of the glycerin = $1.3\times10^{3}$ kg $m^{-3}$ and viscosity of the glycerin =0.83 $Nsm^{-2}$. [Ans. $9.8\times10^{2}$ Pa]

92. 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]

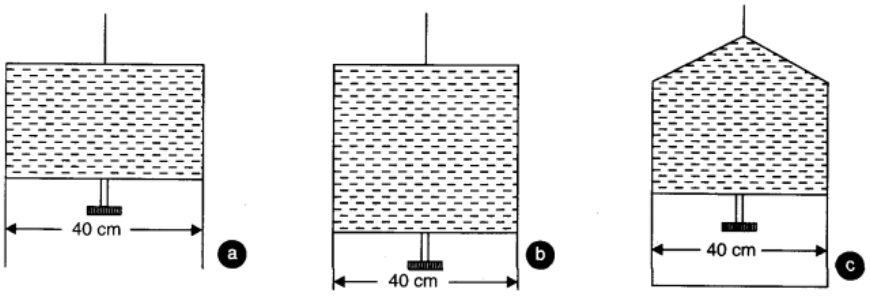
93. Figures refer to the steady flow of a (non-viscous) liquid. Which of the two figures is incorrect? Why?




94. The cylindrical tube of spray pump has a cross-section of 8.0 $cm^2$, one end of which has 40 fine holes each of diameter 10 mm. If the liquid flow inside the tube is 15 m $min^{-1}$, what is the speed of ejection of the liquid through the holes? [0.637 $ms^{-1}$]

95. U-shaped wire is dipped in a soap solution, and removed. The thin soap film formed between the wire and a light slider supports a weight of $1.5\times10^{-2}$N (which includes the small weight of the slider). The length of the slider is 30cm. What is the surface tension of the film? [Ans. $2.5\times10^{-2}$ $Nm^{-1}$]

96. Figure shows a thin liquid film supporting a small weight = $4.5\times10^{-2}$ N. What is the weight supported by a film of the same liquid at the same temperature in figures? Explain your answers physically.



97. What is the pressure inside a drop of mercury of radius 3.00 mm of room temperature? Surface tension of mercury at that temperature (20°C) is $4.65\times10^{-1}$ $Nm^{-1}$. The atmospheric pressure is $1.01\times10^{5}$ Pa. Also give the excess pressure inside the drop.

[Ans. $1.013510^{5}$ Pa]

98. What is the excess pressure inside a bubble of soap solution of radius 5.00mm? Given that the surface tension of soap solution at the temperature (20°C) is $2.50\times10^{-2}$ $Nm^{-1}$. If an air bubble of the same dimension were formed at a depth of 40.0 cm inside a container containing the soap solution of relative density 1.20, what would be the pressure inside the bubble? (1 atm = $1.01\times10^{5}$ Pa) [Ans. 105714 Pa]

99. A tank with a square base of area $1.0m^2$ is divided by a vertical partition in the middle. The bottom of the partition has a small hanged door of area 20 $cm^2$. The tank is filled with water in one compartment, and an acid (of relative density 1.7) in the other, both to a height of 4.0m. Compute the force necessary to keep the door closed.

100. Two vessels have the same base area but different shapes. The first vessel takes twice the volume of water that the second vessel requires to fill upto a particular common height.
(i) Is the force exerted by the water on the base of the vessel the same in the two cases?
(ii) If so, why do the vessels filled with water to that same height give different readings on a weighing scale?

101. During blood transfusion the needle is inserted in a vein where the gauge pressure is 2000 Pa. At what height must the blood container be placed so that blood may just enter the vein? The density of whole blood = $1.06\times10^{3}$ kg $m^{-3}$. [Ans. 0.1925 m]

102. In deriving Bernoulli's equation, we equated the work done on the fluid in the tube to tis change in the potential and kinetic energy. (a) How does the pressure change as the fluid moves along the tube if dissipative forces are present? (b) Do the dissipative forces become more important as the fluid velocity increases? Discuss quantitatively.

103. (a) What is the largest average velocity of blood flow in an artery of radius $2\times10^{-3}$m if the flow must remain laminar? (b) What is the corresponding flow rate? Take viscosity of blood to be $2.084\times10^{-3}$ Pa s and density of blood = $1.06\times10^{3}$ kg $m^{-3}$.

[Ans. (a) 0.98 m/s (b) $1.23\times10^{-2}m^3s^{-1}$]

104. A plane is in level flight at constant speed and each of its two wings has an area $25m^2$. If the speed of the air is 180 km/h over the lower wing and 234 km/h over the upper wing surface, determine the plane's mass. Take air density to be 1 kg $m^{-3}$ and g = 9.81 $ms^{-2}$.

[Ans. 4396 kg]

105. In Millikan's oil drop experiment, what is the terminal speed of a drop of a radius $2.0\times10^{-5}$ m and density $1.2\times10^{3}$kg $m^{-5}$? Take the viscosity of air at the temperature of the experiment to be $1.8\times10^{-5}$ $Nsm^{-2}$. How much is the viscous force on the drop at that speed? Neglect buoyancy of the drop due to air. [Ans. $3.9\times10^{-1}$ N]

106. Mercury has an angle of contact equal to 140° with soda lime glass. A narrow tube of radius 1.00 mm made of thin glass is dipped in a trough 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 the experiment is 0.465 $Nm^{-1}$. Density of mercury = $13.6\times10^3$ $kgm^{-3}$. [Ans. – 5.34 mm]

107. (a) It is known that density of ρ of air decreases with height y as

$$\rho = \rho_0 e^{-y/y_0}$$

where $r_0$ = 1.25 kg $m^{-3}$ is the density at sea level and $y_0$ is a constant. The density variation is called the law of atmospheres. Obtain this law assuming that the temperatures of atmosphere remains a constant (isothermal conditions). Also assume that the value of g remains constant.

(b) A large he balloon of volume 1425 $m^3$ is used to lift a pay load of 400 kg. Assume that the balloon maintains constant radius as it rises. How high does it rise?

[Ans. (b) 8km]

**(5 marks Questions)**

108. (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?

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

110. 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.

111. 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.

112. 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.

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

114. (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.

115. (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.

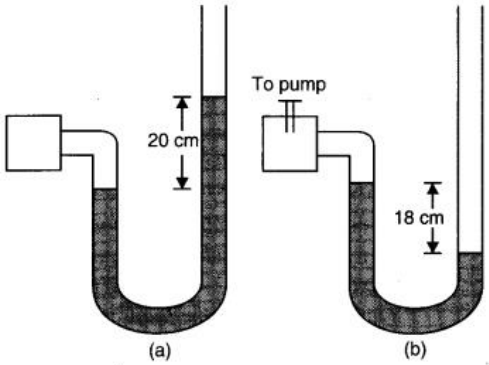
116. (i) Derive an expression for the excess pressure inside a soap bubble.
(ii) State Bernoulli's therorem.

117. Explain why:
(a) The blood pressure in humans is greater at the feet than at the brain.
(b) Atmospheric pressure at a height of about 6km decreases to nearly half its value at the sea level, though the height of the atmosphere is more than 100 km.
(c) Hydrostatic pressure is a scalar quantity even though pressure is force divided by area, and force is a vector.

118. Explain why:
(a) The angle of contact of mercury with glass is obtuse, while that of water with glass is acute.
(b) Water on a clean glass surface tends to spread out while mercury on the same surface tends to form drops. [Put differently, water wets the glass while mercury does not].
(c) Surface tension of a liquid is independent of the area of the surface.
(d) Detergents should have small angles of contact.
(e) A drop of liquid under no external forces is always spherical in shape.

119. Explain why:
(i) To keep a piece of paper horizontal, you should blow over, not under it.
(ii) When we try to close a water tap with our fingers, fast jets of water gush through the openings between our fingers.
(iii) The size of the needle of a syringe controls flow rate better than the thumb pressure exerted by a doctor while administering an injection.
(iv) A fluid flowing out of a small hole in a vessel results in a backward thrust on the vessel.
(v) A spinning cricket ball in air does not follow a parabolic trajectory.

120. 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]