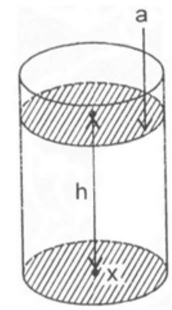
Pressure in Fluids

1. Derive an expression for pressure in a liquid at a point which is at a depth 'h' units and density of
liquid is 'ρ' units.



Ans. Consider a point x, at a depth 'h' in a liquid of density 'ρ' such that 'a' is the area of a cross section of vessel.

Wt. of liquid in vessel (Thrust) = a.h.ρ.g.

Pressure of liquid $= \frac{\text{Thrust}}{\text{atrea}} = \frac{\text{ah}\rho\text{g}}{\text{a}}$ = h.ρ.g.

2. *State three factors which determine the pressure of a fluid at a given point within the fluid.*

Ans. Pressure of a liquid at a given point ∝ depth
∝ density of fluid
∝ acceleration due to gravity.

3. *Pressure in case of solids is inversely proportional to area of cross-section. Does the above statement hold for fluids? Explain your answer.*

Ans. No, the statement does not hold for the pressure in fluids.

Pressure in fluids is given by the expression 'hρg' and hence is independent of area of cross-section.

4. *Briefly describe an experiment to prove :*

(i) *Pressure in fluids is directly proportional to depth.*

(ii) *Pressure in fluids is directly proportional to the density of fluid.*

(iii) *Fluids exert same pressure in all directions.*

Ans. (i) Take a thistle funnel and from its stem cut its funnel. To this funnel attach a thin rubber membrane. On the other side of funnel attach a long plastic tube, connected to U-tube containing coloured water such that the level of water is same in both the limbs.

Lower the funnel in any fluid to different depths. It is observed that the difference of levels of liquid in U-tube increases with the depth. Thus, the pressure in liquids is directly proportional to the depth.

(ii) Lower the above funnel first in water, then in brine and finally in alcohol to the same depth. Record the pressure in each case. It is noticed that pressure is least in case of alcohol, but increases as the density of liquid increases. Thus, pressure is directly proportional to density.

(iii) Hold the above funnel with its membrane pointing (i) vertically upward (ii) vertically downward (iii) side ways, at the same depth in a fluid. It is observed that pressure of fluid does not change as long as the depth remains the same. Thus, the liquids exert same pressure in all directions at a given point.

5. *Explain the following :*

(a) Pressure of water on the first floor building is always less than pressure of water at the ground floor.

(b) Water tank in a locality, is always at higher altitude than buildings in the locality.

Ans. (a) The pressure of a liquid is given by the expression '$P = h\rho g$'. As the vertical height of water column on first floor is less than ground floor, therefore, pressure of water on first floor is less than the ground floor.

(b) Water or any other liquid seeks its own level. Thus, when water tank is situated at the highest point, the water from it will rise up to the tallest building without the aid of any external force.

6. *How does the fluid pressure on a balloon changes when :*

(a) balloon rises up from a height of 200 m to a height of 500 m?

(b) balloon moves horizontally at a height 200 m?

(c) balloon is brought down on the surface of earth?

Ans. (a) The fluid pressure decreases as the vertical height of air column as measured from above decreases.

(b) The fluid pressure remains the same as the vertical height does not change.

(c) The fluid pressure increases as the vertical height of air as measured from above increases.

7. *Fill in the blanks with appropriate words or phrases.*

(a) The pressure of sea water for same depth is __________ than the river water. (less, more)

(b) The pressure of air __________ as we move upward. (increases, decreases)

(c) The fluids exert __________ pressure in all directions at a given point. (different, same)

(d) The fluid pressure of liquid increases with increase in __________ . (depth, area of cross-section)

(e) The fluid pressure of atmosphere is measured in __________ . This is equivalent to __________ Pascals. (bars; Pascals; 100, 300 pascals; 101,300 pascals)

Ans. (a) The pressure of sea water for same depth is **more** than the river water.

(b) The pressure of air **decreases** as we move upward.

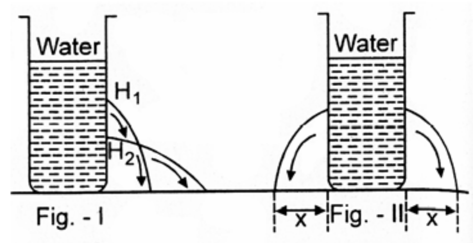
(c) The fluids exert **same** pressure in all directions at a given point.

(d) The fluid pressure of a liquid increases with increase in **depth**.

(e) The fluid pressure of atmosphere is measured in **bars**. This is equivalent to 101,300 pascals.

8. ***(a)*** *What does Fig. I tell about pressure in liquids?*

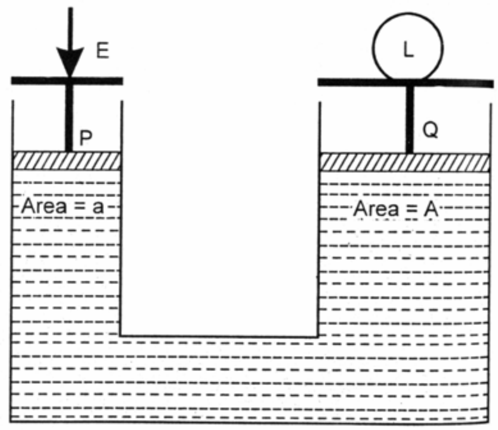
(b) *What does Fig. II tell about pressure in liquids?*



Ans. (a) It shows that fluid pressure is directly proportional to depth.

(b) It shows that fluid pressure at a given depth is same in all directions.

9. *The diagram alongside is a simplified version of hydraulic press. Answer the following questions?*



(i) *Name and state the principle of hydraulic press.*

(ii) *What is the pressure exerted on the piston P?*

(iii) *What is the pressure throughout the fluid?*

(iv) *What is the pressure exerted by the fluid on piston Q?*

(v) *What is the thrust on the piston Q?*

(vi) *Calculate the mechanical advantage of pressure from the above data.*

Ans. (i) **Pascal's Law :** Where any pressure is applied to any part of a boundary of a confined liquid (fluid), it is transmitted equally in all directions, irrespective of the area on which it acts, and acts always at right angles to the surface of containing vessel.

(ii) Pressure on piston P = $\frac{\text{Force}}{\text{Area}} = \frac{E}{a}$

(iii) Pressure exerted by fluid = $\frac{E}{a}$ [As pressure is transmitted equally in all directions]

(iv) Pressure exerted on piston Q = Pressure in fluid = $\frac{E}{a}$

(v) Thrust (force) acting on piston Q in upward direction = Force × area = $\frac{E}{a} \times A$.

(vi) Force (thrust) acting on piston in downward direction = L

$$\therefore \quad L = \frac{E}{a} \times A$$

$$\text{or} \quad = \frac{L}{E}$$

$$MA = \frac{\text{Area of piston Q (A)}}{\text{Area of piston P (a)}}.$$

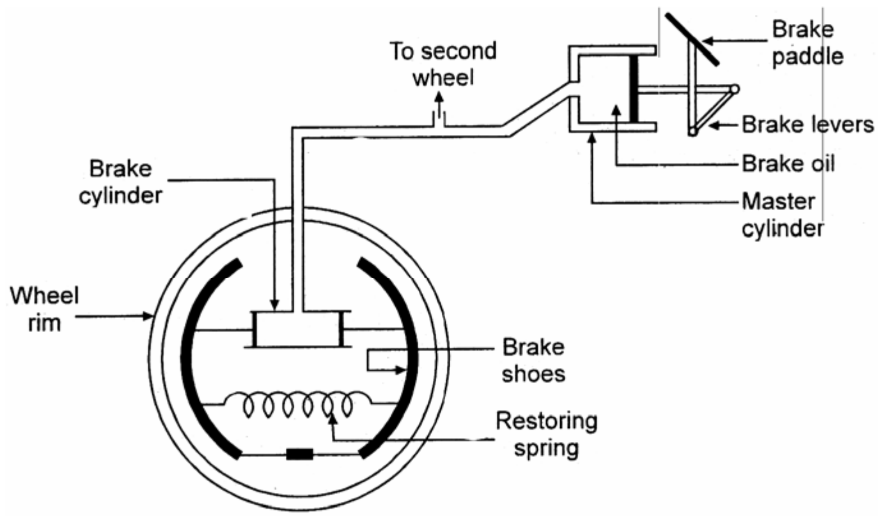
10. *State any two uses of hydraulic press.*

Ans. ***(i)*** It is used for compressing straw and cotton bales.

(ii) It is used for punching holes in metal sheets.

11. *Draw a neat and fully labelled diagram of hydraulic brake.*

Ans.



Hydraulic Brakes

12. ***(a)*** *What do you understand by the term atmospheric pressure?*

(b) *What is the cause of atmospheric pressure?*

(c) *State the numerical value of atmospheric pressure at sea level in (i) cm of mercury (ii) pascals (iii) bars.*

Ans. **(a)** The thrust per unit area exerted by air on the surface of earth is called atmospheric pressure.

(b) It is the weight of air (thrust), which is responsible for the atmospheric pressure.

(c) (i) The atmospheric pressure at sea level is 76 cm of mercury.

(ii) The atmospheric pressure at sea level is 101300 pascals.

(iii) The atmospheric pressure at sea level is 1.013 bar.

13. *(a) Name the instrument used for measuring the atmospheric pressure.*

(b) How will you set up such an instrument in a laboratory?

(c) State the precautions for the use of this instrument.

Ans. (a) Barometer

(b) Take a tube 1 m long, closed at one end. Fill it completely with mercury. By placing thumb on the open end of tube, invert the tube in the bowl of mercury and then remove the thumb. It is seen that fairly large length of mercury is supported in the tube. On measuring, the length of mercury from its level in tube to the level of mercury in the bowl, it is found to be 76 cm at sea level. This length is equivalent to atmospheric pressure.

(c) Precautions :

1. The barometer tube should be perfectly clean and dry.
2. The mercury should be pure and dry.
3. No air bubbles should be left inside the tube filled with mercury.
4. Record the vertical height of mercury column in the tube, by holding the tube in an upright position.

14. *Explain the following :*

(a) Why is water not a suitable barometric liquid?

(b) Why is mercury used as a barometric liquid?

(c) Name two factors which do not affect barometric height at a given place.

(d) Name four factors which affect barometric height at a given place.

Ans. (a) (i) Water barometer will support 10.34 m of water at sea level. It is impractical to have such a long tube.

(ii) Water vaporises under vacuum conditions and hence water barometer will never show true atmospheric pressure.

(b) (i) The vapour pressure of mercury is almost negligible under vacuum conditions. Thus, mercury barometer shows true atmospheric pressure.

(ii) Mercury is the densest liquid (13.6 g cm^{-3}) at room temperature. Thus, a short column of mercury can exert as much pressure as atmosphere.

(iii) Mercury does not wet the sides of glass and can be had in pure state.

(c) (i) Barometric height is independent of area of cross-section of barometric tube.

(ii) Barometric height is independent of angle to which barometer tube is held.

(d) (i) Barometric height changes with change in temperature.

(ii) Barometric height changes with change in humidity in air.

(iii) Barometric height changes, if mercury is impure.

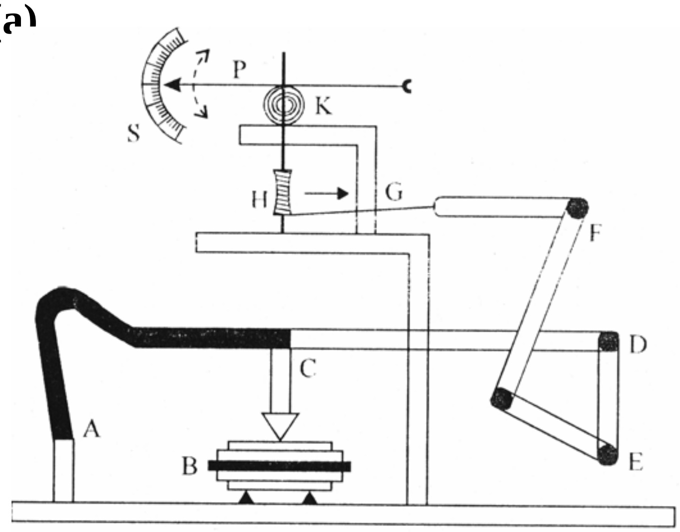
(iv) Barometric height changes, if tube is not dry.

15. *(a) Draw a neat fully labelled diagram of aneroid barometer.*

(b) Explain how aneroid barometer is used for

(i) Forecasting weather (ii) As an altimeter.

Ans. (a)



A = Flat spring
B = Evacuated box
C = Central levers
DEFG = System of levers
G = Metallic chain
H = Pulley
K = Hair spring
P = Pointer
S = Graduated scale

(b) (i) If the barometric height on a particular day is less than normal height, it shows fall in pressure. If fall in pressure is steep it could mean dust storm or rain. However, if there is gradual drop in pressure, it means that weather will change from normal to windy. If there is no change in height, it is fair weather. If there is a rise in barometric height it means dry or anticyclonic weather.

(ii) **Altimeter** : It has been established that for a vertical rise of 105 m, the barometric height drops by 1 m. This fact is used in the construction of altimeter, where fall in length of mercury column is calibrated as height of a place.

16. *State the forecast in the following situations :*

(a) Air is hot and dry and atmospheric pressure falls suddenly.
(b) Air is humid and barometric pressure falls suddenly.
(c) Barometric pressure rises steeply.
(d) Barometric pressure does not change.
(e) Barometric pressure falls gradually over number of days.

Ans. **(a)** The forecast is dust storm.
(b) The forecast is rain storm.
(c) The forecast is dry weather with strong anticyclonic winds.
(d) The forecast is fair weather.
(e) The forecast is that weather gradually changes from fair to windy over number of days.

17. *Explain the following :*

(a) Sense of hearing is affected while rapidly gaining or losing height.
(b) The nose of some people starts bleeding when an aeroplane climbs up rapidly.
(c) A soda straw does not draw liquid, if there is a tiny hole near its upper end.
(d) Why are passenger cabins in an aeroplane pressurised?
(e) Why do the bodies of deep sea fishes burst, on bringing them above the sea level?

(f) *Why does an ink pen start leaking at higher altitudes?*

(g) *Why are special suits worn by astronauts while floating in space?*

(h) *Why are weather observation balloons filled partially with helium gas at ground level?*

(i) *Why are two holes made in oil tin, to remove oil from it?*

(j) *Why does not liquid run out of a dropper, unless rubber bulb is pressed?*

Ans. (a) When a person rapidly gains or loses height, the air pressure outside the ear drum changes with respect to air pressure on the other side of ear drum in eustachian tube. Thus, the ear drum either bulges in or out and hence does not vibrate properly. It is on account of this reason that hearing is affected.

(b) When one suddenly gains height, the atmospheric pressure suddenly drops. Thus, the pressure of dissolved air in blood becomes too large as compared to air outside. This difference in atmospheric pressure sometimes bursts the fine capillaries in the nose and hence it starts bleeding.

(c) If there is a hole near the upper end of soda straw, the atmospheric pressure does not fall due to suction. As atmospheric pressure within the straw does not fall, therefore, air pressure will not force the liquid up in the straw.

(d) This is done so that passengers do not feel the ill effects of sudden drop in pressure, such as bleeding of nose or vomiting, etc.

(e) The blood of deep sea fishes contains dissolved oxygen at a very very high pressure as compared to atmospheric pressure. Thus, when such fishes are brought to the sea level, the difference in pressure of oxygen within their bodies and atmosphere bursts open their bodies.

(f) When the atmospheric pressure on high altitudes decreases, the air present within the tube of ink pen at higher pressure, forces the ink out. Thus, the ink pen starts leaking.

(g) There is no atmospheric pressure in space. Thus, bodies of astronauts can burst due to internal pressure of dissolved oxygen in the blood, if not properly protected. It is for this reason that astronauts wear special suits, which keep the pressure outside their bodies equal to pressure inside their bodies.

(h) On higher altitudes atmospheric pressure decreases. Thus, the balloon starts expanding because of difference of pressure inside and outside the balloon. Thus, to allow expansion, such that fabric of balloon does not burst, the balloon is filled partially at ground level.

(i) If the single hole is made, the oil will not flow out because it will be supported by atmospheric pressure. Thus, in order to force out the oil, two holes are made, so that air enters from one hole, exerts pressure on the oil and forces it out from the other hole.

(j) It is because, the liquid is supported by atmospheric pressure. However, when we press the rubber bulb, the pressure of air within the dropper becomes more than atmospheric pressure and hence it forces out the liquid.

18. ***(i)*** *What unit does pascal meature?*

Ans. (*i*) The unit pascal measures pressure.

Hydrostatic pressure = hρg

$$= \frac{40}{100}\ \text{m} \times 1000\ \frac{\text{kg}}{\text{m}^3} \times 9.8\frac{\text{m}}{\text{s}^2}$$

= **3920 Pa.**

19. **(*i*)** *State whether the pressure acting at a point in a liquid is a scalar quantity or vector quantity.*

(*ii*) *A glass container contains a liquid of density ρ, when the height of liquid is 'h' and acceleration due to gravity is 'g'. If P_A is the atmospheric pressure, calculate:*

(1) The pressure the free surface of the liquid.

(2) The total pressure at the base of container.

(3) What is the magnitude of lateral pressure the base of liquid on the inner side of container?

Ans. **(i)** The pressure acting at a point in a liquid is a scalar quantity.

(ii) (1) Pressure on the free surface of the liquid is P_A.

(2) The total pressure at the base of liquid is P_A + hρg.

(3) The magnitude of lateral pressure is P_A + hρg.

Numericals

20. *Calculate pressure exerted by* 0.8 *m vertical length of alcohol of density 0.80 g cm–3 in pascals.* *[Take g = 10 ms^{-2}]*

Ans. h = 0.8 m, ρ = 0.80 gcm^{-3} = 800 kg m^{-3}, g = 10 ms^{-2}

P = hrg = 0.8 m × 800 kg m^{-3} × 10 ms^{-2} = **6400 Pa.**

21. *What is the pressure exerted by 75 cm of vertical column of mercury of density 13,600 kg m^{-3}?* *[Take g = 9.8 ms^{-2}]*

Ans. h = 75 cm = 0.75 m; ρ = 13,600 kg m^{-3}; g = 9.8 ms^{-2}

P = hρg = 0.75 m × 13,600 kg m^{-3} × 9.8 ms^{-2} = **99,960 Pa.**

22. *The base of a cylindrical vessel measures 300 cm2. Water is poured into it up to the depth of 6 cm. Calculate the pressure on the base of vessel.*

Ans. h = 6 cm = 0.06 m; ρ = 1000 kg m^{-3}; g = 10 ms^{-2}

P = hρg = 0.06 m × 1000 kg m^{-3} × 10 ms^{-2} = **600 Pa.**

23. *The normal pressure of air is 76 cm of mercury. Calculate the pressure in S.I. units. [Density of mercury is 13,600 kg m–3 and g = 10 ms^{-2}]*

Ans. h = 76 cm = 0.76 m; ρ = 13,600 kg m^{-3}; g = 10 ms^{-2}

P = hρg = 0.76 m × 13,600 kg m^{-3} × 10 ms^{-2} = **103,360 Pa**.

24. *The atmospheric pressure at a place is 650 mm of mercury. Express the pressure in (a) pascals(b) millibars.*

[Take rHg = 13,600 kg m–3; g = 9.8 ms^{-2}]

Ans. h = 650 mm = 0.65 m; ρ = 13,600 kg m^{-3}; g = 9.8 ms^{-2}

P = hρg = 0.65 m × 13,600 kg m–3 × 9.8 ms^{-2} = **86632 Pa.**

Pressure in millibars = 88400 ¸ 10^2 = **866.32 mb**

25. *66,640 Pa pressure is exerted by 0.50 m vertical column of a liquid. If g = 9.8 N kg^{-1}, calculate density of the liquid.*

Ans. P = 66,640 Pa; h = 0.50 m; g = 9.8 N kg^{-1}; ρ = ?

$$\rho = \frac{P}{h.g} = \frac{66,640}{0.50 \times 9.8} = \mathbf{13,600\ kg\ m^{-3}.}$$

26. *0.20 m vertical height of alcohol exerts a pressure of 1600 Pa. If g = 10 ms^{-2}, calculate the density of alcohol.*

Ans. P = 1600 Pa; h = 0.20 m; g = 10 ms^{-2}; ρ = ?

$$\rho = \frac{P}{h.g} = \frac{1600}{0.20 \times 10} = \mathbf{800\ kg\ m^{-3}}.$$

27. *What vertical height of water will exert a pressure of 3,33,200 Pa? Density of water is 1000 kg m–3 and g = 9.8 ms^{-2}.*

Ans. h = ?; P = 333200 Pa; ρ = 1000 kg m–3; g = 9.8 ms^{-2}

$$h = \frac{P}{\rho g} = \frac{333200}{1000 \times 9.8} = \mathbf{34\ m}.$$

28. P*ressure at bottom of sea at some particular place is 8,968,960 Pa. If density of sea water is 1040 kg m^{-3}, calculate the depth of sea.*

[Take g = 9.8 ms^{-2}]

Ans. P = 8,968,960 Pa; ρ = 1040 kg m^{-3} g = 9.8 ms–2; h = ?

$$h = \frac{P}{\rho g} = \frac{8{,}968{,}960}{1040 \times 9.8} = \mathbf{880\ m}.$$

29. *Atmospheric pressure at sea level is 76 cm of mercury. Calculate the vertical height of air column exerting the above pressure. Assume the density of air 1.29 kg m^{-3} and that of mercury is 13,600 kg m^{-3}. Why is the height calculated by you far less than actual height of atmosphere?*

Ans. h_{Hg} = 0.76 m; ρ_{Hg} = 13,600 kg m^{-3}; ρ_{air} = 1.29 kg m^{-3}, h_{air} = ?

h_{air} × 1.29 kg m^{-3} = 0.76 m × 13,600 kg m^{-3}

$$h_{air} = \frac{0.76 \times 13600}{1.29}\ m = 8012.40m = \mathbf{8.0124\ km.}$$

In the above question it is assumed that density of air is a constant quantity. However, in actual practice density of air decreases rapidly with gain of height. Thus, actual height of atmosphere is far greater than calculated height.

30. *Calculate the equivalent height of mercury, which will exert as much pressure as 960 m of sea water of density 1040 kg m^{-3}. Density of mercury is 13,600 kg m^{-3}.*

Ans. h_{Hg} = ?; $h_{s.water}$ = 960 m; ρ_{Hg} = 13,600 kg m^{-3}, $\rho_{s.water}$ = 1040 kg m^{-3}

$$h_{Hg} \times \rho_{Hg} = h_{s.water} \times r_{s.water}$$

$$h_{Hg} \times 13{,}600 \text{ kg m}^{-3} = 960 \text{ m} \times 1040 \text{ kg m}^{-3}$$

$$\therefore h_{Hg} = \frac{960 \times 1040}{13{,}600} \text{m} = \mathbf{73.41 \text{ m.}}$$

31. *The pressure of water on ground floor in a water pipe is 150,000 Pa, whereas the pressure on fourth floor is 30,000 Pa. Calculate the height of fourth floor. [Take g = 10 ms^{-2}].*

Ans. Pressure of water on ground floor = 150,000 Pa

Pressure of water on fourth floor = 30,000 Pa

∴ Difference in pressure of water = 120,000 Pa.

Also, difference in pressure of water= $h_{water} \times r_{water} \times g$

120,000 Pa = h_{water} × 1000 kg m^{-3} × 10 ms^{-2}

∴ h_{water} = 12 m.

∴ Height of fourth floor = **12 m.**

32. *The pressure of water on ground floor is 160,000 Pa. Calculate the pressure at fifth floor, at a height of 15 m. [Take g = 10 ms^{-2}]*

Ans. Pressure at the ground floor = 1,60,000 Pa.

Height of fifth floor = 15 m.

∴ Pressure due to 15 m of water = h.ρ.g. = 15 m × 1,000 kg m–3 × 10 ms^{-2} = 1,50,000 Pa.

∴ Pressure on fifth floor = (1,60,000 – 1,50,000) = **10,000 Pa.**

33. *The pressure in a water pipe on ground floor of a building is 40,000 Pa, whereas on first floor is 10,000 pascals. Find the height of first floor. [Take $g = 10\ ms^{-2}$]*

Ans. Pressure of water on ground floor = 40,000 Pa.

Pressure of water on first floor = 10,000 Pa.

∴ Difference in pressure of water = 30,000 Pa.

Also, difference in pressure of water = $h_{water} \times \rho_{water} \times g$

30,000 Pa = $h_{water} \times 1{,}000\ kg\ m^{-3} \times 10\ ms^{-2}$ $h_{water} = 3$ m.

∴ Height of the first floor = **3 m.**

35. *Pressure in a water pipe on ground floor of a building is 100,000 Pa. Calculate the pressure in water pipe at a height of 3 m. [Density of water = 1000 kg m–3, g = 10 N kg^{-1}].*

Ans. Pressure at the ground floor = 100,000 Pa.

∴ Pressure due to 3 m of water = h.ρ.g. = 3 m × 1000 kg $m^{-3} \times 10\ ms^{-2}$ = 30,000 Pa.

∴ Pressure on the first floor at a height of 3 m

= (1,00,000 – 30,000) Pa. = **70,000 Pa.**

36. *The atmospheric pressure is 105 N m^{-2} and density of water is 103 kg m^{-3}. Calculate the depth of water at which pressure is double than atmospheric pressure.*

Ans. Let the atmospheric pressure = P

∴ $2P = P + [h_w \times \rho_w \times g]$

$P = h_w \times \rho_w \times g$

$105\ N\ m^{-2} = h_w \times 1{,}000\ kg\ m^{-3} \times 10\ ms^{-2}$

∴ $h_{water} = 10$ m.

37. *Calculate the depth of salt water lake, if the pressure at its base is 16 times the atmospheric pressure. The density of salt water is 1050 kg m–3 and acceleration due to gravity is 10 ms–2. The atmospheric pressure is 10 N cm^{-2}.*

Ans. Let the atmospheric pressure = P

∴ Pressure at the bottom of lake = 16 P.

$$\therefore \quad 16\text{ P} = \text{P} + [h_{s.water} \times \rho_{s.water} \times g]$$

$$15\text{ P} = h_{s.water} \times \rho_{s.water} \times g$$

$$15 \times 10\text{ N cm–2} = h_{s.water} \times 1050\text{ kg m}_{-3} \times 10\text{ ms}_{-2}$$

$$15 \times 100{,}000\text{ N m}_{-2} = h_{s.water} \times 1050\text{ kg m}_{-3} \times 10\text{ ms}_{-2}$$

$$\therefore \quad h_{s.water} = \text{ m} = \mathbf{142.85\text{ m.}}$$

38. *The surface area of the upper surface of a submarine is 200 m^2. If the submarine is 70 m below the sea water, calculate the total force acting on its upper surface.*
[Density of sea water =
1040 kg m^{-3}, density of mercury = 13,600 kg m^{-3}, atmospheric pressure = 75 cm of mercury and g = 10 ms^{-2}].

Ans. Surface area of upper surface = 200 m^2

Pressure due to air = $h_{Hg} \times \rho_{Hg} \times g$ = 0.75 m × 13,600 kg m^{-3} × 10 ms^{-2} = 1,02,000 Pa.

Pressure due to sea water only = $h_{s.water} \times \rho_{s.water} \times g$
= 70 m × 1040 kg m^{-3} × 10 ms^{-2} = 7,28,000 Pa.

∴ Total pressure acting on the surface of submarine
= (7,28,000 + 1,02,000) = 8,30,000 Pa.

∴ Total force acting on the surface of submarine
= P × a = 830000 × 200 = **166,000,000 N.**

39. *A metal plate of length 1.5 m and width 0.2 m is placed 40 cm below alcohol of density*
800 kg m^{-3}. If the atmospheric pressure is 80 cm of mercury, calculate the force experienced by the plate. [Density of mercury is 13,600 kg m–3 and g = 10 ms^{-2}].

Ans. Surface area of plate $= 1.5 \text{ m} \times 0.2 \text{ m} = 0.3 \text{ m}^2$

Pressure due to air only $= h_{Hg} \times \rho_{Hg} \times g =$ m × 13,600 kg m–3 × 10 ms^{-2}

$= 108{,}800$ Pa.

Pressure due to alcohol only $= h_{alc} \times r_{alc} \times g = 0.40 \text{ m} \times 800 \text{ kg m}^{-3} \times 10 \text{ ms}^{-2} = 3{,}200$ Pa.

∴ Total pressure acting on plate = (108,800 + 3,200) = 1,12,000 Pa.

∴ Force acting on plate = P × a = 1,12,000 × 0.3

= 33,600 N.

40. *The areas of cross-section of pump plunger and press plunger of a hydraulic press are 0.02 m^2 and 8 m^2 respectively. If the hydraulic press overcomes a load of 800 kgf, calculate the force applied at the end of the handle of the pump plunger. If the mechanical advantage of the handle of pump plunger is 8, calculate the force applied at the end of the handle of the pump plunger.*

Ans. For Hydraulic Press :

$$= \frac{\text{Load overcome by press plunger}}{\text{Effort applied on pump plunger}} = \frac{\text{Area of cross-section of press plunger}}{\text{Area of cross-section of pump plunger}}$$

$$\frac{800 \text{ kgf}}{\text{Effort}} = \frac{8\text{m}^2}{0.02\text{m}^2}$$

$$\therefore \quad \text{Effort} = \frac{800 \text{ kg} \times 0.02}{8} = \mathbf{2 \text{ kgf}}$$

For the handle of pump plunger

$$\text{MA} = \frac{\text{Effort on pump plunger}}{\text{Effort applied on the end of handle}}$$

$$8 = \frac{2\text{kgf}}{\text{Effort applied on the end of handle}}$$

$$\therefore \quad \text{Effort applied on the end of handle} = \frac{2\text{kgf}}{8} = \mathbf{0.25 \text{ kgf.}}$$

41. *The radii of press plunger and pump plunger are in the ratio of 50 : 4. If an effort of 40 kgf acts on pump plunger, calculate the maximum resistance the press plunger can overcome.*

Ans. $$\frac{\text{Resistance overcome by press plunger}}{\text{Effort applied on pump plunger}} = \frac{(\text{Radius of press plunger})^2}{(\text{Radius of pump plunger})^2}$$

$$\frac{\text{Resistance overcome by press plunger}}{40\text{kgf}} = \frac{(50)^2}{(4)^2}$$

$$\therefore \text{ Resistance overcome by press plunger} = \frac{2500 \times 40}{16} = \mathbf{6250\ kgf.}$$