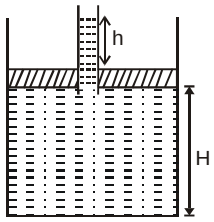
# Exercise - III (SUBJECTIVE PROBLEMS)

## 1. STATIC FLUID

**1.** A piston of mass M = 3 kg and radius R = 4 cm has a hole into which a thin pipe of radius r = 1 cm is inserted. The piston can enter a cylinder tightly and without friction, and initially it is at the bottom of the cylinder. 750 gm of water is now poured into the pipe so that the piston & pipe are lifted up as shown. Find the height H of water in the cylinder and height h of water in the pipe. (Neglect width of piston)



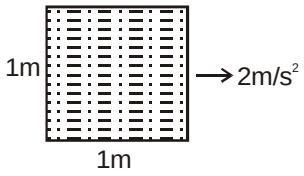

**2.** Compute the work which must be performed to slowly pump the water out of a hemispherical reservoir of radius R = 0.6 m.

**3.** A vertical uniform U tube open at both ends contains mercury. Water is poured in one limb until the level of mercury is depressed 2cm in that limb. What is the length of water column when this happens.

## 2. ACCELERATED FLUID

**4.** A spherical tank of 1.2m radius is half filled with oil of relative density 0.8. If the tank is given a horizontal acceleration of 10 m/s$^2$. Calculate the inclination of the oil surface to horizontal and maximum pressure on the tank.

**5.** An open cubical tank completely filled with water is kept on a horizontal surface. Its acceleration is then slowly increased to 2m/s$^2$ as shown in the fig. The side of the tank is 1m. Find the mass of water that would spill out of the tank.




**6.** Find the speed of rotation of 1 m diameter tank, initially full of water such that water surface makes an angle of 45° with the horizontal at a radius of 30 cm. What is the slope of the surface at the wall of the tank.

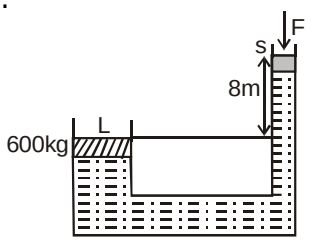
## 3. PASCAL'S LAW & ARCHIMEDE'S PRINCIPLE

**7.** A solid ball of density half that of water falls freely under gravity from a height of 19.6 m and then enter water. Upto what depth will the ball go ? How much time will it take to come again to the water surface ? Neglect air resistance & velocity effects in water.

**8.** Place a glass beaker, partially filled with water, in a sink. The beaker has a mass 390 gm and an interior volume of 500 cm$^3$. You now start to fill the sink with water and you find, by experiment, that if the beaker is less than half full, it will float; but if it is more than half full, it remains on the bottom of the sink as the water rises to its rim. What is the density of the material of which the beaker is made?

**9.** Two spherical balls A and B made up of same material having masses 2m and m are released from rest. Ball B lies at a distance h below the water surface while A is at a height of 2h above water surface in the same vertical line at the instant they are released.
(a) Obtain the position where they collide.
(b) If the bodies stick together due to collision, to what maximum height above water surface does the combined mass rise?
Specific gravity of the material of the balls is 2/3. Neglect viscosity and loss due to splash.

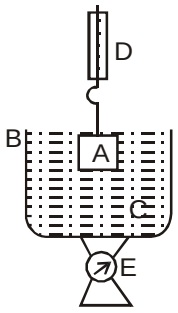
**10.** For the system shown in the figure, the cylinder on the left at L has a mass of 600kg and a cross sectional area of 800 cm$^2$. The piston on the right, at S, has cross sectional area 25cm$^2$ and negligible weight. If the apparatus is filled with oil. ($\rho$ = 0.75 gm/cm$^3$) Find the force F required to hold the system in equilibrium.




**11.** A test tube of thin walls floats vertically in water, sinking by a length $l_0$ = 10 cm. A liquid of density less than that of water, is poured into the tube till the levels inside and outside the tube are even. If the tube now sinks to a length $l_0$ = 40 cm, the specific gravity of the liquid is _____.

**12.** In air an object weighs 15N, when immersed completely in water the same object weighs 12N. When immersed in another liquid completely, it weighs 13N. Find
(a) the specific gravity of the object and
(b) the specific gravity of the other liquid.

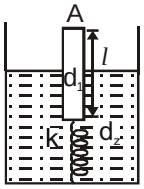
**13.** Block A in figure hangs by a cord from spring balance D and is submerged in a liquid C contained in a beaker B. The mass of the beaker is 1kg & the mass of the liquid is 1.5 kg. The balance D reads 2.5 kg & balance E reads 7.5 kg. The volume of block A is 0.003 $m^3$.




(i) What is the density of block & the liquid.
(ii) What will each balance read if block is pulled out of the liquid.

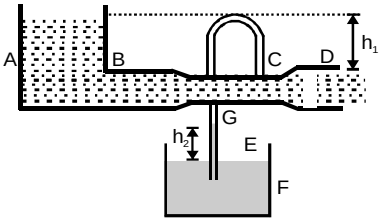
**14.** A solid cube, with faces either vertical or horizontal, is floating in a liquid of density 6 g/cc. It has two third of its volume submerged. If enough water is added from the top so as to completely cover the cube, what fraction of its volume will remain immersed in the liquid?

**15**. A uniform cylindrical block of length $l$ density $d_1$ and area of cross section A floats in a liquid of desity $d_2$ contained in a vessel ($d_2 > d_1$). The bottom of the cylinder just rests on a spring of constant k. The other end of the spring is fixed to the bottom of the vessel. The weight that may be placed on top of the cylinder such that the cylinder is just submerged in the liquid is _____

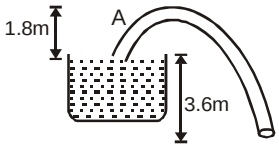



## 4. FLUID FLOW & BERNOULLI'S PRINCIPLE

**16.** Two very large open tanks A and F both contain the same liquid. A horizontal pipe BCD, having a constriction at C leads out of the bottom of tank A, and a vertical pipe E opens into the constriction at C and dips into the liquid in tank F. Assume streamline flow and no viscosity. If the cross section at C is one half that at D and if D is at a distance $h_1$ below the level of liquid in A, to what height $h_2$ (in terms of $h_1$) will liquid rise in pipe E ? (above G & upto C there is air in the pipe)

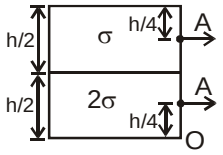



**17.** A siphon has a uniform circular base of diameter $8/\sqrt{\pi}$ cm with its crest A 1.8 m above water level as in figure.




Find
(a) velocity of flow
(b) discharge rate of the flow in $m^3$/sec.
(c) absolute pressure at the crest level A.
[Use $P_0 = 10^5$ N/$m^2$ & g = 10 m/$s^2$]

**18.** A large tank is filled with two liquids of specific gravities $2\sigma$ and $\sigma$. Two holes are made on the wall of the tank as shown. Find the ratio of the distances from O of the points on the ground where the jets from holes A & B strike.




**19.** Calculate the rate of flow of glycerine of density $1.25 \times 10^3$ kg/$m^3$ through the conical section of a pipe if the radii of its ends are 0.1 m & 0.04 m and the pressure drop across its length is 10 N/$m^2$

**20.** The tank in fig discharges water at constant rate for all water levels above the air inlet R. The height above datum to which water would rise in the manometer tubes M and N respectively are _____ & _____ .