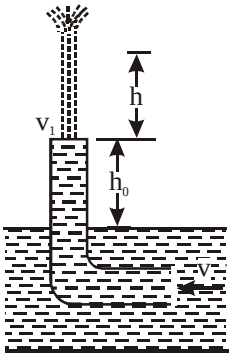
SUBJECTIVE UNSOLVED LEVEL – II

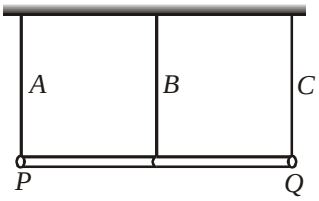
1. A drop of water of mass $m = 0.2\,g$ is placed between two clean glass plates, the distance between which is 0.01 cm. Find the force of attraction between the plates. Surface tension of water = 0.07 N m^{-1}.

2. A bent tube is lowered into a water stream as shown in figure. The velocity of the stream relative to the tube is equal to $\upsilon = 2.5 m/s$. The closed upper end of the tube located at the height $h_0 = 12$ cm has a small orifice. To what height h will the water jet spurt?



3. Water is flowing continuously from a tap having a bore of internal diameter 8×10^{-3} m. Calculate the diameter of the water stream at a distance 2×10^{-1} m below the tap. Assume that the water velocity as it leaves the tap is $4\times10^{-1} m/s$.

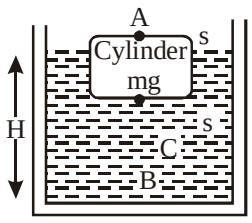
4. In figure, PQ represents a uniform bar of mass 10 kg supported horizontally by three uniform wires A, B and C of the same length attached symmetrically to the bar. The wires A and C are of copper 1 sq. mm in cross-section and B of iron 2 sq. mm in cross-section. If the Y for copper and iron is 1×10^{11} and 2×10^{11} N/m^2 respectively, find the tension in each wire.



5. A liquid of density ρ is filled in a beaker of cross-section S to a height H and then a cylinder of mass m and cross-section s is made to float in it as shown in figure. If the atmospheric pressure is P_0, find the pressure

(a) at the top face A of the cylinder
(b) at the bottom face C of the cylinder and
(c) at the base B of the beaker

Can ever these three pressure be equal ?



6. A body weights m_1 in a fluid of density d_1 and m_2 in a fluid of density d_2. What would be its weight in a fluid of density d_3 ?

7. A rod AD consisting of three segments AB, BC and CD joined together is hanging vertically from a fixed support at A. The lengths of the segments are respectively 0.1 m, 0.2 m and 0.15 m. The cross-section of the rod is uniformly $10^{-4} m^2$. A weight of 10 kg is hung from D. Calculate the displacements of point B, C and D using the data on Young's moduli given below (neglect the weight of the rod).

$Y_{AB} = 2.5\times10^{10}\ N/m^2$

$Y_{BC} = 4.0\times10^{10}\ N/m^2$ and

$Y_{CO} = 1.0\times10^{10}\ N/m^2$.

8. There is soap bubble of radius 2.4×10^{-4} m in air cylinder which is originally at the pressure of $10^5\,N/m^2$. The air in the cylinder is now compressed isothermally until the radius of the bubble is halved. Calculate now the pressure of air in the cylinder. The surface tension of the soap film is $0.08\,Nm^{-1}$.

9. Two separate air bubbles (radii 0.002 m and 0.004 m) formed of the same liquid (surface tension 0.070 N/m) come together to form a double bubble. Find the radius and the sense of curvature of the internal film surface common to both the bubbles.

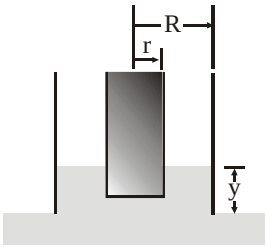
10. Two spherical soap bubbles coalesce. If V is the consequent change in volume of the contained air and S the change in the total surface area, show that

$$3PV + 4ST = 0$$

where T is the surface tension of the soap bubble and P the atmospheric pressure.

SUBJECTIVE UNSOLVED LEVEL – III

1. A solid glass rod of radius r = 1.3 cm is placed inside and coaxial with a glass cylinder of internal radius R = 1.7 cm. Their bottom ends are aligned and placed in contact with, and perpendicular to, the surface of an open tank of water (see figure).Two what height will the water rise in the region between the rod and the cylinder ? Assume that the angle of contact is 0º and use 72.8 mN/m for the surface tension of water.



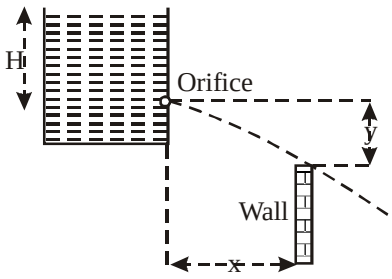
2. A thin uniform metallic rod of length 0.5 m and radius 0.1 m rotates with an angular velocity 400 rad s^{-1} in a horizontal plane about a vertical axis passing through one of its ends. Calculate the tension in the rod and the elongation of the rod. The density of the material of the rod is 10^4 kg m^{-3} and the Young's modulus is $2\times10^{11}\,Nm^{-2}$.

3. A ring of radius 0.1 m is made out of a thin metallic wire of area of cross section 10^{-6} m^2. The ring has a uniform charge of π coulomb. Find the change in the radius of the ring when a charge of 10^{-8} coulomb is placed at the centre of the ring. Young's modulus of the metal is $2\times10^{11}\,Nm^{-2}$.

4. A glass capillary sealed at the upper end is of length 0.11 m and internal diameter 2×10^{-5} m. The tube is immersed vertically into a liquid of surface tension 5.06×10^{-2} N/m. To what length the capillary has to be immersed so that the liquid level inside and outside the capillary becomes the same. What will happen to liquid level inside the capillary if the seal is now broken ?

5. A sphere of radius 0.1 m and mass 8π kg is attached to the lower end of a steel wire of length 5.0 m and diameter 10^{-3} m. The wire is suspended from 5.22 m high ceiling of a room. When the sphere is made to swing as a simple pendulum, it just grazes the floor at its lowest point. Calculate the velocity of the sphere at the lowest position young's modulus of the steel is $1.994\times10^{11}\,Nm^{-2}$ $1.994\times10^{11}\,Nm^{-2}$.

6. For the arrangement shown in figure, find the time interval after which the water jet ceases to cross the wall. Area of the tank is A and area of orifice is a.



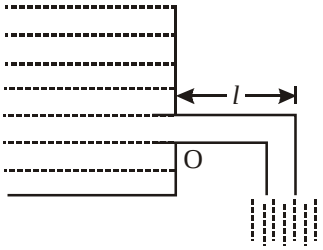
7. Two cylindrical tanks are filled with different liquids. A small hole is made in the side of each tank at the same depth h below the surface of liquid. If the hole in the tank has a area of cross-section twice that of hole in tank B.

(a) What is the ratio ρ_1 / ρ_2, the densities of two liquids, if same mass of two liquids flows out from both tanks per unit time?

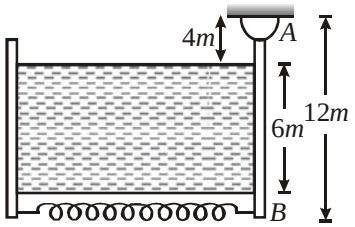
(b) What is the ratio of volumes of two liquids flowing out per unit time from each tank?

(c) What should be the relative heights of liquid columns in the two tanks for equal rate of volume flow?

8. Water flows out of a big tank along a tube bent at right angles. The inside radius of the tube is r. The length of horizontal section of tube is l. The flow rate of water is Q (shown in figure). Find the moment of reaction forces of flowing water acting on tube walls relative to the point O. Density of water is ρ.



9. .A barrier AB of length 12m is hinged at A. At the lower end a horizontal spring keeps the barrier closed. The height of water is 6m and the width of the barrier is 5m. Water level is 4m below the hinge A. If elongation of the spring to keep the barrier closed is 1m, find its spring constant (k). Neglect atmospheric pressure. ($g = 10\,\text{m/s}^2$)



10. A steel ball of diameter $d = 3.0$ mm starts sinking with zero initial velocity in olive oil whose viscosity is $\eta = 0.90\,P$. How soon after the beginning of motion will be velocity of the ball differ from the steady-state velocity by $n = 1.0\%$?