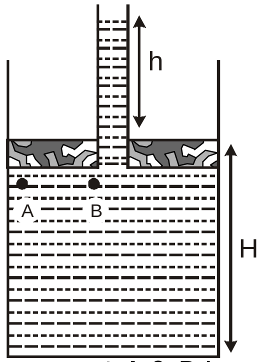
EXERCISE – III SUBJECTIVE PROBLEMS

1.



Pressure at A & B is same

So, $P_A = P_B$

$\Rightarrow P_0 + \dfrac{Mg}{\pi(R^2 - r^2)} = P_0 + \rho gh$

$\Rightarrow h = \dfrac{M}{\pi(R^2 - r^2)\rho_w}$

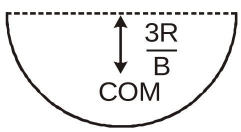
Now,

Total water is cylinder + Total water in pipe

$= \dfrac{750}{1000}$ Kg $\quad \Rightarrow \pi R^2 H\rho + \pi r^2 h\rho = \dfrac{750}{1000}$

$H = \left(\dfrac{3}{4} - \pi r^2 h\rho\right)\dfrac{1}{\pi R^2 \rho}$

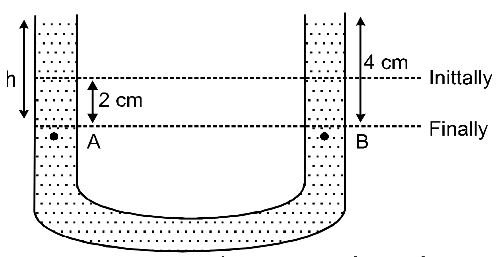
2.



W = mgh

$= \dfrac{2}{3}\pi R^3 \rho \times g \times h$

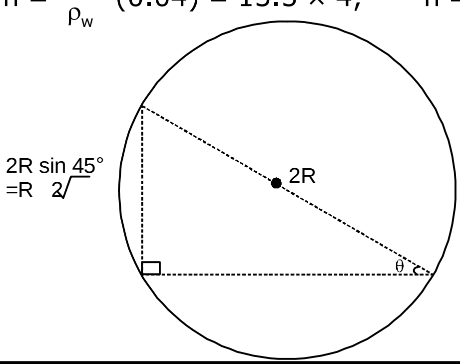
3.



$P_A = P_B \quad \Rightarrow \rho_w gh = \rho_{Hg}\, g\,(0.04)$

$h = \dfrac{\rho_{Hg}}{\rho_w}(0.04) = 13.5 \times 4, \qquad h = 54$ cm

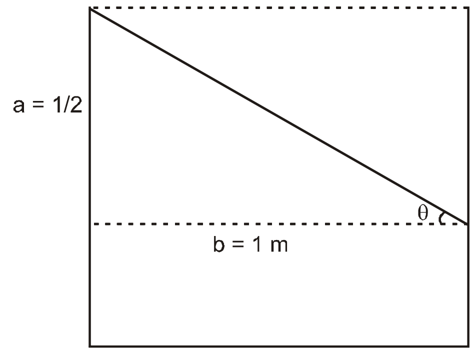
4.



$\theta = \tan^{-1}\dfrac{a}{g} = 45°$

$\therefore P_{max} = \rho g R\sqrt{2}$

5.

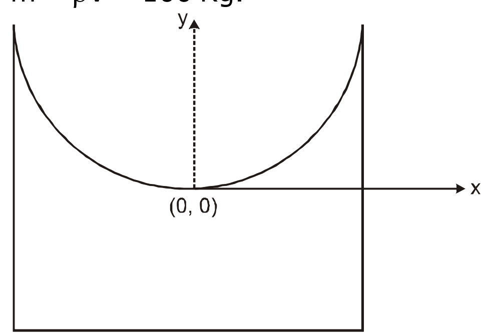


$\tan\theta = \dfrac{2}{10} = \dfrac{1}{5}$

$V = \dfrac{(b)^2 a}{2} = \dfrac{1 \times 1 \times 1/5}{2} = \dfrac{1}{10} m^3$

$m = \rho V = 100$ Kg.

6.



$y = \dfrac{\omega^2 x^2}{2g} \qquad \dfrac{dy}{dx} = \dfrac{\omega^2 x}{g}$

$\dfrac{dy}{dx} = 1$ at $x = 0.3$ m $\Rightarrow \omega = \sqrt{\dfrac{10}{0.3}} = \dfrac{10}{\sqrt{3}}$ rad/s.

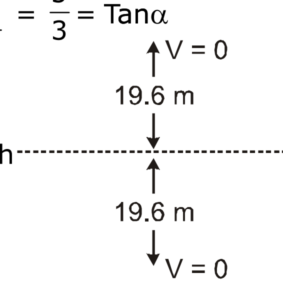
$\left.\dfrac{dy}{dx}\right|_{x=\frac{1}{2}m} = \dfrac{\left(\dfrac{10}{\sqrt{3}}\right)^2 \times \dfrac{1}{2}}{10} = \dfrac{5}{3} = \text{Tan}\alpha$

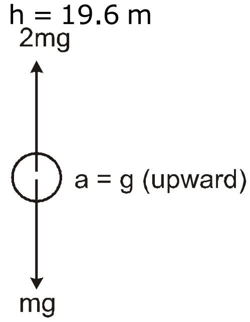
7. $W_{net} = \Delta K = 0$

$\Rightarrow W_{mg} = W_B = 0$

$mg(19.6 + h) = 2\,mgh$

$h = 19.6$ m





$\therefore \frac{1}{2}gt^2 = h$

t = 2 sec

T = 2t = 4 sec.

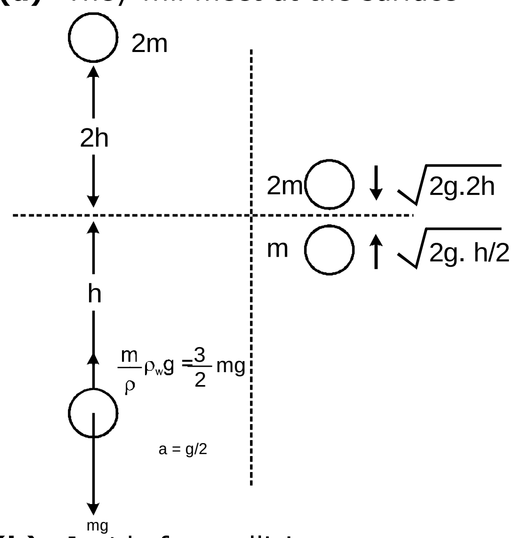
8. $m + \frac{V}{2}\rho_w = \left(\frac{m}{\rho} + V\right)\rho_w$

m = mass of beaker

V = interior volume of beaker

f = density of material of beaker

9.(a) They will meet at the surface



(b) Just before collision

2m ○ ↓ $\sqrt{2g.2h}$

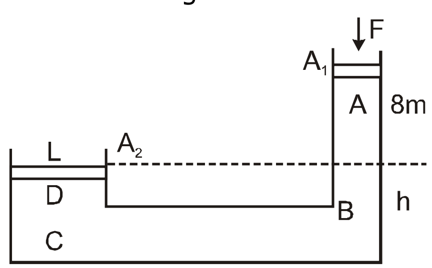
m ○ ↑ $\sqrt{2g/2.h}$

Just After collision

(3m) ↓ $\sqrt{gh}$

$\therefore H_{max} = \frac{(\sqrt{gh})^2}{2g} = \frac{h}{2}$

10.



Pressure at point A = $\frac{F}{A_1}$

Pressure at point B= $\frac{F}{A_1}$ +ρg(8+h)

Pressure at point C = Pr. at B

Pressure at D = P_C – ρgh

$= \left[\frac{F}{A_1} + \rho gh\right]$

Now at equilibrium

$(600)\,g = \left[\frac{F}{A_1} + \rho g 8\right] A/2$

(600) g =

$\left[\frac{F}{25 \times 10^{-4}} + 750 \times 10 \times 8\right] 800 \times 10^{-4}$

$\frac{60}{8} = \frac{F}{25} + 6 \Rightarrow \boxed{F = 37.5N}$

11. $m = A\ell_0\,\rho_w$

$m + A\,\ell\,\rho = A\ell\,\rho_w$

m = mass of the test tube and lead

A = Area of Cross section

ℓ_0 = 10 cm

ℓ = 40 cm $\Rightarrow \frac{\rho}{\rho_w} = \frac{\ell - \ell_0}{\ell} = 0.75$

12.(a) $15 - 12 = \frac{m}{\rho}.\rho_w.g$

$3 = \frac{mg}{\rho/\rho_w}$ $\frac{\rho}{\rho_w} = 5$

(b) $15 - 13 = \frac{m}{\rho}.\rho_\ell.g$

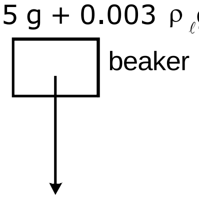
$3 = \frac{\rho_\ell}{\rho} = \frac{2}{15}$, $\frac{\rho_\ell}{5\rho_w} = \frac{2}{15}$, $\frac{\rho}{\rho_w} = \frac{2}{3}$

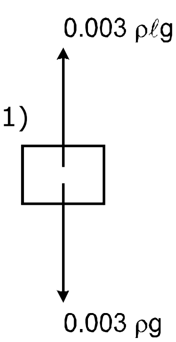
13. a

$0.003\,\rho g - 0.003\,\rho_\ell g = 2.5\,g$

$\rho - \rho_\ell = \frac{2.5}{3} \times 1000$ .... (1)

$2.5\,g + 0.003\,\rho_\ell g = 7.5$





$\rho_\ell = \frac{7.5 - 2.5}{0.003} = \frac{5000}{3}$ Kg/m^3

$\rho = \frac{2.5 \times 1000}{3} + \frac{5000}{3}$

= 2500 Kg/m^3

(b) E = 1 + 1.5 = 2.5 Kg

Δ = 2500 × 0.003 = 7.5 Kg

14. $\frac{2}{3}V\rho_\ell = V\rho$

$nV\rho_\ell + (1 - n)\,V\rho_w = V\rho = \frac{2}{3}V\rho_\ell$

$n = \frac{2\rho - 3\rho_w}{3(\rho_\ell - \rho_w)} = \frac{3}{5}$

15. $A\ell d_1 = Axd_2$ $\quad x = \dfrac{\ell d_1}{d_2}$

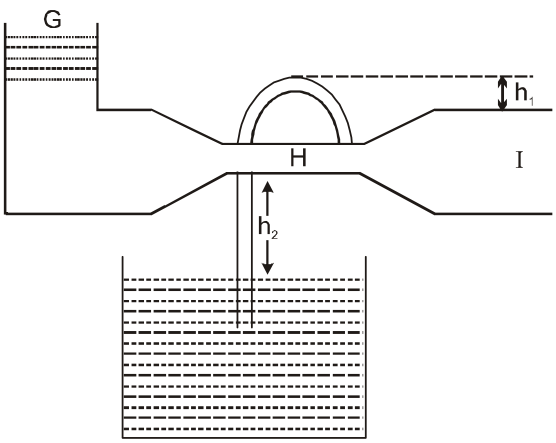
$K(\ell - x) + A\ell d_2 g = A\ell d_1 g + m$

$m = K\left[\ell - \dfrac{\ell d_1}{d_2}\right] + A\ell g d_2 - A\ell g d_1$

$= \dfrac{K\ell(d_2 - d_1)}{d_2} + A\ell g\,(d_2 - d_1)$

$= \ell(d_2 - d_1)\left[\dfrac{K}{d_2} + Ag\right]$

16.



Applying Bernoulli's theorem b/w G & I we get

$P_0 + \rho g h_1 = P_0 + \dfrac{1}{2}\rho V^2$

& b/w I & H

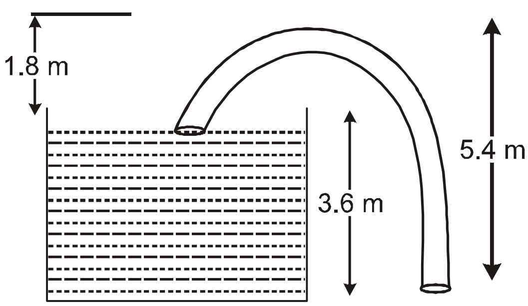
$P_H + \dfrac{1}{2}\rho(2V)^2 = P_0 + \dfrac{1}{2}\rho V^2$

$P_H = P_0 - \dfrac{3}{2}\rho V^2 = P_0 - 3\rho gh$

$P_H = P_0 - \rho g h_2$ $\quad \Rightarrow 3\rho g h_1 = \rho g h_2$

$h_2 = 3h_1$

17.



(a) $\rho g(3.6) = \dfrac{1}{2}\rho V^2$

$V = 6\sqrt{2}$ m/s

(b) Discharge rate of flow = AV

$= \pi\left(\dfrac{4}{\sqrt{\pi}}\right)^2 \times 10^{-4} \times 6\sqrt{2}$

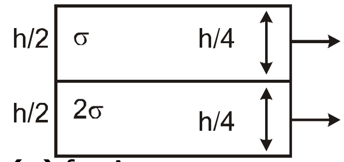
$9.6\sqrt{2} \times 10^{-3} m^3/s$

(c)

$P_A = P_0 - \rho g(5.4)$

$= 10^5 - 10^5(5.4),$ $\quad = 4.6 \times 10^4$ N/m^2

18.



(a) for A

$\rho g\dfrac{h}{4} = \dfrac{1}{2}\rho v^2$ $\quad v = \sqrt{g\dfrac{h}{2}}$

$R_A = vT$

$= \sqrt{g\dfrac{h}{2}} \cdot \sqrt{\dfrac{3h}{4} \cdot \dfrac{2}{g}}$ $\quad R_A = \sqrt{3}\dfrac{h}{2}$

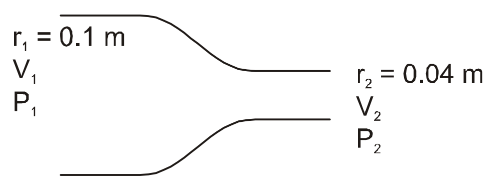
(b) for B

$2\sigma g\dfrac{h}{4} + \sigma g\dfrac{h}{2} = \dfrac{1}{2}.2\sigma v^2$ $\quad gh = v^2$

$v = \sqrt{gh}$ $\quad R_B = \sqrt{gh}\sqrt{\dfrac{2h}{4g}} = \dfrac{h}{\sqrt{2}}$

$= \dfrac{R_A}{R_B} = \dfrac{\sqrt{3}h}{2h}\sqrt{2}$ $\quad = \dfrac{\sqrt{3}}{\sqrt{2}}$

19.

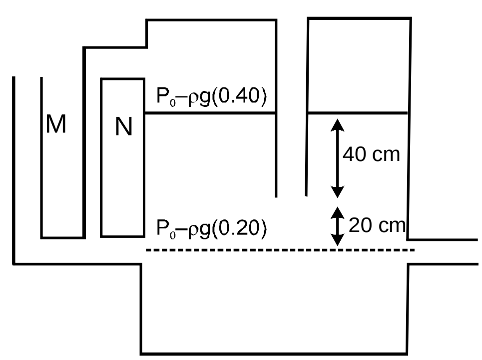


From $A_1V_1 = A_2V_2$

and $P_1 + \dfrac{1}{2}\rho V_1^2 = P_2 + \dfrac{1}{2}\rho V_2^2$

and $P_1 - P_2 = 10 N/m^2$

20.



In N water level is = 60 cm.

In M = 20 cm.