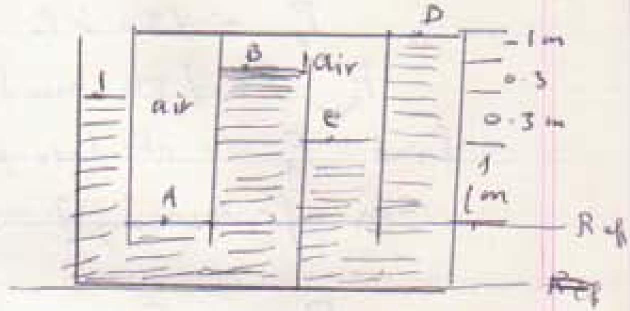
Problems

2.2



$\cancel{P_1} + \gamma h_1 = P_A$

$0 + 9810 \times 1.3 = P_A$

$\therefore P_A = 12.753\ kPa$

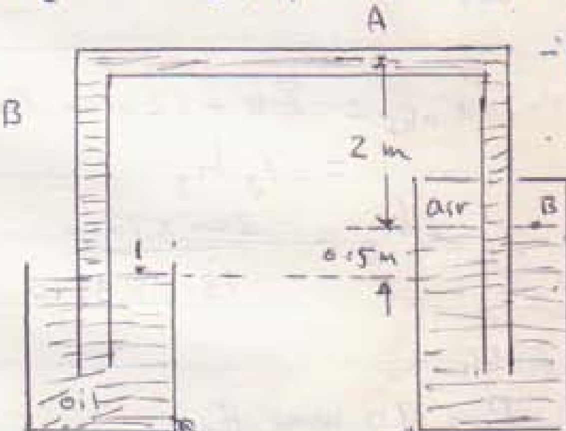
$P_1 + \gamma_1 h_1 - \gamma_2 h_2 = P_B \quad \therefore 0 + 9810 \times 1.3 - 9810 \times 1.6 = P_B$

$\therefore P_B = -2.943\ kPa = P_C \quad P_C + \gamma_1 h_1 - \gamma_2 h_2 = P_D$

$\therefore P_D = -18.639\ kPa.$

2.3

find the pressure at A, B in meter of water?



Relative density 0.85

$P_1 - \gamma h_1 + \gamma h_2 = P_B$

$0 - 0.85 \times 2.5 \times 9810$

$+ 0.85 \times 9810 \times 2 = P_B$

$P_B = 0.85 \times 9810 \times (2 - 2.5)$

$= -0.425 \times 9810 = -4169.25\ N/m^2$

$P_B = \gamma_{oil} h_{oil} = \gamma_w h_w$

$h_w = \frac{\gamma_{oil} h_{oil}}{\gamma_w} = \frac{-0.425 \times \cancel{9810}}{\cancel{9810}} = -0.425\ m$ of H_2O

also

$0 - \gamma h_1 = P_A = -20846\ N/m^2$

$\therefore P_A = -\gamma_{oil} h_{oil} = \gamma_w h_w \quad \therefore h_w = \frac{-0.85 \times \cancel{9810} \times 2.5}{\cancel{9810}}$

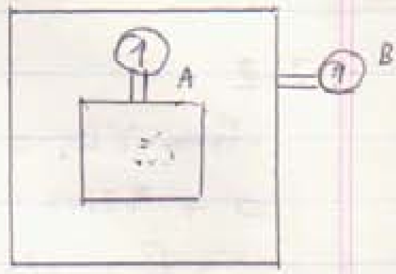
$h_w = -2.125$ m of water.

Q.13 $P_A = 80$ kPa gage

$P_B = 120$ kPa gage

$P_{bar} = 750$ mm Hg

find P_A in absolute pressure in cm of mercury?



$$P_{abs} = P_{gage} + P_{bar}$$

$$P_{bar} = 13.6 \times 9810 \times 0.75 = 100 \text{ KPa}$$

$$\therefore P_{A\,abs} = 80 + 120 + 100 = 300 \text{ KPa}$$

$$= \gamma_g h_g$$

$$\therefore h_g = \frac{300 \times 1000}{13.6 \times 9810} = 2.25 \text{ m of Hg}$$

$$= 225 \text{ cm of Hg}$$

Q.2.24

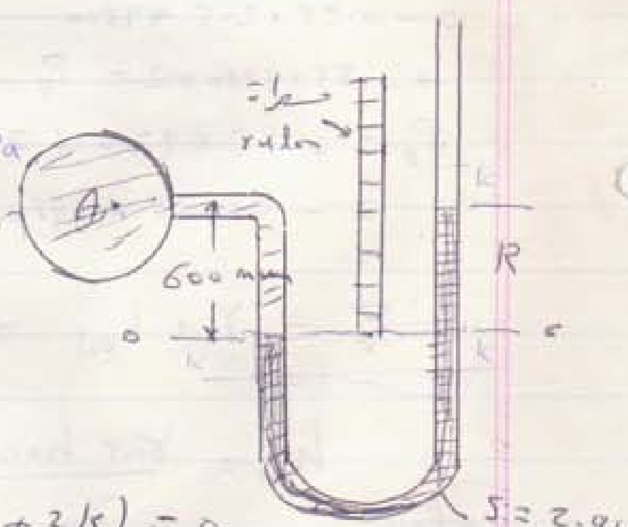
a) $P_A = 90$ mm H_2O

$$= \gamma_w h_w = 9810 \times 0.09 = \text{Pa}$$

$$P_A + \gamma_w h_1 - \gamma_s R = 0$$

$$9810 \times 0.09 + 9810 \times 0.6 - 2.94 \times 9810 R = 0$$

$$R = 0.2347 \text{ m}$$



b) $P_A = 8$ kPa

$$P_A + \gamma_w(h_1 + k) - \gamma_s(R + 2k) = 0$$

$$8000 + 9810(0.6 + k) - 2.94 \times 9810(0.2347 + 2k) = 0$$

$$\therefore k = 0.148 \text{ m}$$

The total Reading without adjustment $= k + R = 0.148 + 0.23$

$$= 0.383 \text{ m.}$$

Q 2-4 $\quad P_a + \gamma h_1 - \gamma h_2 = 0$

$\therefore P_a = \gamma h_2 - \gamma h_1 = 9810\,(1.6 - 2.2)$

$= -5.88$ KPa.

$P_b + 9810 \times 1 - 1.6 \times 9810 = 0$

$P_b = 5.88$ KPa

$P_c = P_b = 5.88$ $\quad$ أهمال ضغط الهوا ،

$P_D = P_c + 1.4 \times 0.9 \times 9810 = 22.54$ KPa.

Q. 2.14

a) Water $\quad \gamma_w h_w = \gamma_g \cdot h_g$

$9810 \times h_w = 13.6 \times 9810 \times 0.2$

$h_w = 2.72$ m

b) Kerosene $\quad \gamma_k h_k = 13.6 \times 9810 \times 0.2$

$h_k = \dfrac{13.6 \times 9810 \times 0.2}{0.83 \times 9810} = 3.277$ m

c) acetylene

$h_{as} = \dfrac{13.6 \times 9810 \times 0.2}{2.94 \times 9810} = 0.925$ m

Q. 2.16

$P_a + \gamma h = 0 \qquad P_a = -9810 \times 0.83 \cdot h = 30000$

$\therefore h = 3.688$ m

Q. 2.19 $\quad P_A = \gamma h_w$

$\gamma_g h_g = \gamma_w h_w \qquad \therefore h_g = \dfrac{9810 \times 0.075}{9810 \times 13.6} \times 1000$

$= 5.5$ mm Hg.

Q. 2-20 $\quad S_1 = 1.0 \quad S_2 = 0.95 \quad S_3 = 1.0$

$h_1 = h_2 = 280$ mm $\quad h_3 = 1$ m

$P_A - P_B = ?$ in metre of water.

$$P_A - \gamma_1 h_1 - \gamma_2 h_2 + \gamma_3 h_3 = P_B$$

$$P_A - P_B = \gamma_1 h_1 + \gamma_2 h_2 - \gamma_3 h_3$$

$$= 9810 \times 0.28 + 9810 \times 0.95 \times 0.28 - 9810 \times 1 \times 1$$

$$= -4.45 \text{ kN/m}^2$$

$$\therefore h_A - h_B = \frac{-4.45 \times 1000}{9810} = 0.454 \text{ m } H_2O$$

$$= 454 \text{ mm } H_2O$$

Q. 2-22

a) $P_A + S_1 \gamma_w h_1 - S_2 \gamma_w h_2 - S_3 \gamma_3 h_3 = P_B$

$$P_A + 0.83 \times 9810 \times 0.15 - 13.6 \times 9810 \times 0.07 - 0.83 \times 9810 \times 0.12 = 70000$$

$$P_A = 79.09 \text{ kPa}.$$

b)

$$P_{abs} = P_{g} + P_{atm} \qquad \therefore P_g = 140000 - 13.6 \times 9810 \times 0.72$$

$$= 43.9 \text{ kPa}$$

$\therefore$

$$43900 + 0.83 \times 9810 \times 0.15 - 13.6 \times 9810 \times 0.07 - 0.83 \times 9810 \times 0.12 = P_B$$

$$\therefore P_B = 34.82 \text{ kPa}$$

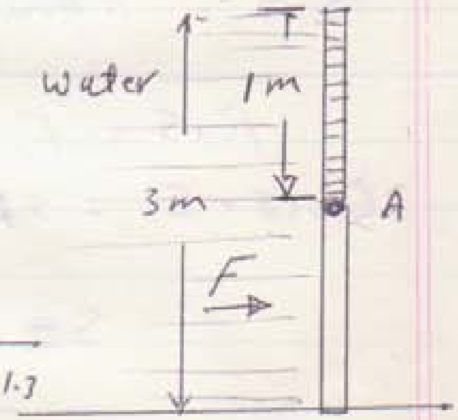
$$\therefore h_B = \frac{P_B}{\gamma_w} = 3.55 \text{ m of water.}$$

2.42 $F = P_G A = \gamma \bar{h} A$

$= 9810 \times 2 \left(\pi r_1^2 - \pi r_2^2 \right)$

$= 46.2 \text{ kN}$

Q.43



1.3 m wide

$F = P_G A = \gamma \bar{h} A$

$= 9810 \times 2 \times 2 \times 1.3$

$= 51.012 \text{ kN}$

$y_p = \bar{y} + \dfrac{I_G}{\bar{y} A} = 2 + \dfrac{1.3 \times 2^3}{12 \times 2 \times 2 \times 1.3}$

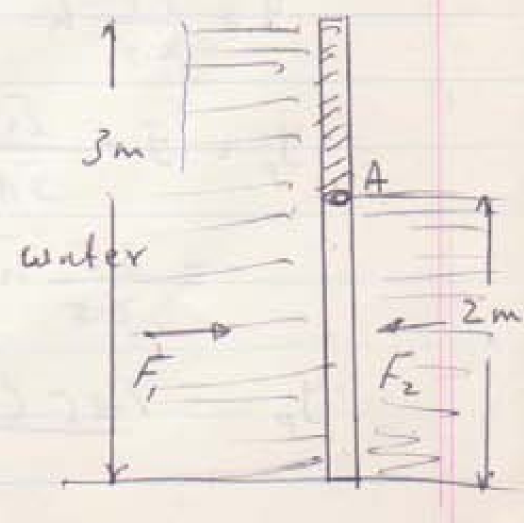
$= 2.166 \text{ m}$

The moment about A

$M_A = F \times (y_p - 1) = 51.012 \times (2.166 - 1)$

$= 59.5 \text{ kN.m}$

Q.44



$F_1 = P_G A = \gamma \bar{h} A$

$= 9810 \times 2 \times 2 \times 1.3 =$

$= 51.012 \text{ kN}$

$y_{p_1} = 2 + \dfrac{1.3 \times 2^3}{12 \times 2 \times 2 \times 1.3} = 2.166 \text{ m}$

$F_2 = 9810 \times 1 \times 2 \times 1.3 =$

$= 25.506 \text{ kN}$

$$y_{P_2} = 1 + \frac{1.3 \times 2^3}{12 \times 1 \times 2 \times 1.3} = 1.333 \text{ m}$$

$$R = F_1 - F_2 = 25.506 \text{ kN} \rightarrow$$

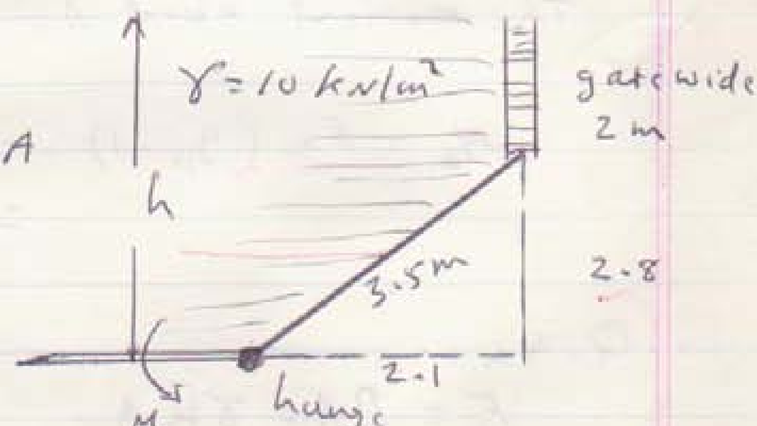
$\Sigma M = 0$ about A [illegible]

$$R \times S = F_1(y_{p_1} - 1) - F_2 \times y_{p_2}$$

$$25.506 \times S = 51.012(1.166) - 25.506 \times 1.333$$

$S \simeq 1$ m the line of action of the resultant force from A

Q. 2.45



$$F = \gamma \bar{h} A$$

$$= \gamma (h - 1.4) A$$

when $\bar{h} = h - 1.4$

$$\bar{h} = \bar{y} \sin\theta$$

$$\bar{y} = \frac{3.5}{2.8} \bar{h}$$

$$y_p = \bar{y} + \frac{I_G}{\bar{y} A} = \frac{3.5}{2.8}\bar{h} + \frac{2 \times 3.5^3}{12 \times \frac{3.5}{2.8}\bar{h} \times 3.5 \times 2}$$

$$= \frac{3.5}{2.8}\bar{h} + \frac{3.5^3 \times 2.8}{12\,\bar{h}} = 1.25\bar{h} + \frac{0.82}{\bar{h}}$$

$$y_p = \frac{1.25(h - 1.4)^2 + 0.82}{(h - 1.4)}$$

$\Sigma M = 145\,kN.m \quad F(L - y_p)$

$L \sin\theta = h \qquad \therefore L = \frac{3.5}{2.8} h$

$\therefore 14{,}5000 = \gamma A (h - 1.4)\left(\frac{3.5}{28} h - \left(1.25(h-1.4) + \frac{0.82}{h-1.4}\right)\right)$

$14{,}5000 = 10000 \times 2 \times 3.5 (h - 1.4)\left(\cancel{1.25h} - \cancel{1.25h} + 1.75 - \frac{0.82}{h-1.4}\right)$

$= 70000 (h - 1.4)\left(1.75 - \frac{0.82}{h-1.4}\right)$

$\frac{145000}{70000} = 1.75(h - 1.4) - 0.82$

$= 1.75h - 2.45 - 0.82$

$\therefore h = 3.05\ m$

Q. 46

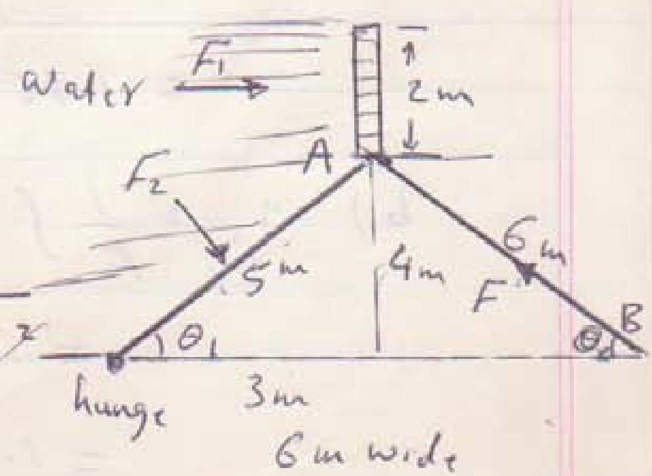
$F_1 = \gamma \bar{h} A$

$= 9810 \times 1 \times 2 \times 6$

$= 117.72\ kN$

$y_{p_1} = \bar{y} + \frac{I_G}{\bar{y} A} = 1 + \frac{6 \times 2^3}{12 \times 1 \times 6 \times 2}$

$= 1.333\ m$



$F_2 = \gamma \bar{h} . A = 9810 \times 4 \times 5 \times 6$

$= 1177.2 \text{ kN}$

$y_{p_2} = \bar{y} + \frac{I_G}{\bar{y} A}$ $\quad \bar{h} = \bar{y} \sin\theta_1 \quad \therefore \bar{y} = \frac{4}{\sin\theta} = 5 \text{ m}$

$= 5 + \frac{6 \times 5^3}{12 \times 5 \times 6 \times 5} = 5.41 \text{ m}$

$\Sigma M = 0$ about the hinge.

$F_1 (6 - y_{p_1}) + F_2 (L - y_{p_2}) - F\cos\theta_2 \times 4 - F\sin\theta_2 \times 3 = 0$

$L \sin\theta_1 = h = 6 \quad \therefore L = 7.5$

$\sin\theta_2 = \frac{4}{6} \qquad \cos\theta_2 = \frac{4.47}{6}$

$\therefore \quad F = 602.37 \text{ kN}.$

Q. 47

a) $y_p = \bar{y} + \frac{I_G}{\bar{y} A} = \left(\frac{0.48}{3} + 1.6 \right) + \frac{b h^3}{36 \times 1.76 \times \frac{1 \times 0.48}{2}}$

$= 1.76 + \frac{1 \times 0.48^3 \times 2}{36 \times 1.76 \times 0.48} = 1.76727 \text{ m}$

b) $y_p = \frac{1}{F} \int y P \, dA = \frac{\int \bar{y}^2 dA}{\bar{y} A} \qquad dA = l \, dy$

$= \frac{\int_{1.6}^{2.08} (2.08 y^2 - y^3) \, dy}{\bar{y} A \times 0.48} = \frac{\left. \frac{2.08}{3} y^3 - \frac{y^4}{4} \right]_{1.6}^{2.08}}{0.48 \times 1.76 \times \frac{0.48}{2}}$

$= 1.76727 \text{ m}$

Q.62 $y_p = \bar{y} + \frac{I_G}{\bar{y}A} = 0.5 + \frac{1\times1^3}{12\times0.5\times1\times1} = 0.666\ m$

$\therefore y = 1 - y_p = 0.333$ The flashbord will tumble.

Q.63 The gate opened when y at pressure center i.e

$y_p = \bar{y} + \frac{I_G}{\bar{y}A} = 1.5 + \frac{1\times1^3}{12\times1.5\times1} = 1.55\ m$

$\therefore y = 2 - 1.55 = 0.45\ m$

Q.65 mass = 2 Mg

$F_1 = \gamma \bar{h}_1 A_1$

$= 8500\times3\times3.33\times2$

$= 170.0136\ kN$

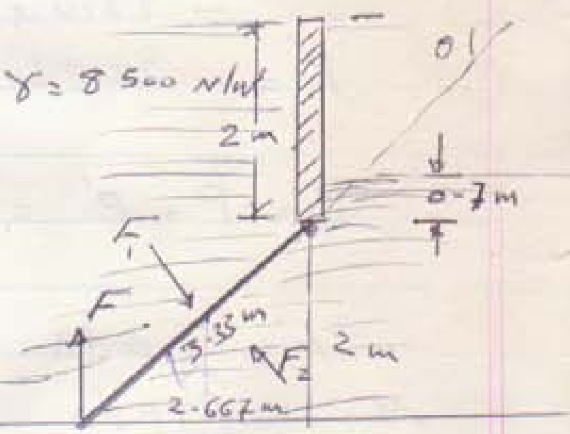
$F_2 = 8500\times1.7\times3.33\times2$

$= 96.32\ kN$

$\bar{y}_1 = 3\times\frac{1}{\sin\theta} = 3\times\frac{3.333}{2} = 5\ m$

$y_{p_1} = \bar{y} + \frac{I_G}{\bar{y}A}$

$= 5 + \frac{2\times3.33^3}{12\times5\times2\times3.33} = 5.185\ m$



Gate wide 2 m.

$W = 2000\times9.81$

$\bar{y}_2 = 1.7\times\frac{3.333}{2} = 2.83\ m$

$y_{p_2} = 2.83 + \frac{2\times3.33^3}{12\times2.83\times2\times3.33} = 3.157\ m$

$\Sigma M = 0$

$F_1\left(y_{p_1} - \frac{2}{\sin\theta}\right) - F_2\left(y_{p_2} - \frac{0.7}{\sin\theta}\right) - F\times2.667m +$

$W\times\frac{2.667}{2} = 0$

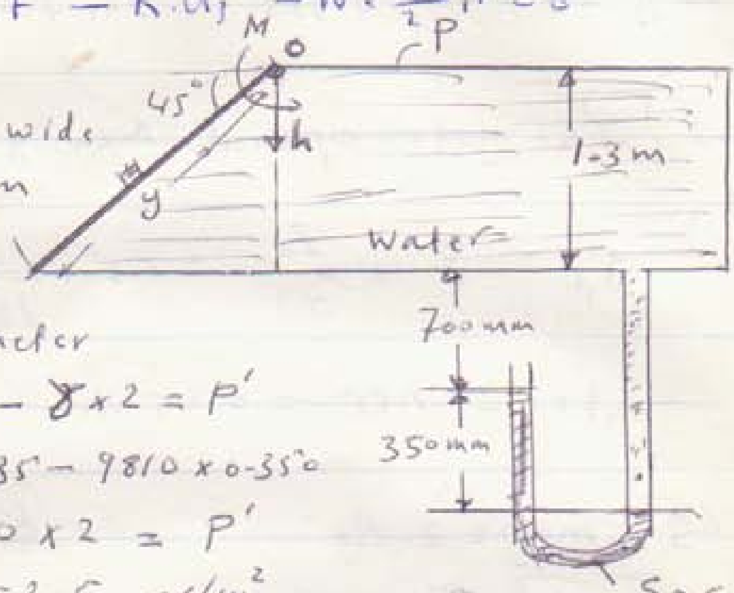
$R = 74\ kN$
~~$a_j = 1.667\,m$~~ }

$-\cancel{170} \times 1.855 + \cancel{96} \times 1.166 \cancel{+} \overset{74}{R} \cdot a_j = 0 \qquad a_j = 2.749$

$170.0136 \times 1.852 - 96.32 \times \cancel{1.166} - F \times 2.667 = $
$+ W \dfrac{2.667}{2} = \qquad \therefore F = \cancel{89}\ kN.\ 85.84\ kN$

$F \cdot 2.667 - R \cdot a_j - W \cdot \dfrac{2.667}{2} = 0$

2-68



from the manometer

$0 + \gamma_s R - \gamma R - \gamma \times 2 = P'$

$0 + 6 \times 9810 \times 0.35 - 9810 \times 0.350$
$- 9810 \times 2 = P'$

$P' = -2452.5\ N/m^2$

$P_G = P + P' = \gamma h + P' = \gamma \dfrac{y}{\sqrt{2}} - 2452.5$
$=$

$F = \int p\, dA$

$M = \int_A y p\, dA = \int y \left(\gamma \dfrac{y}{\sqrt{2}} - 2452.5\right) dA$

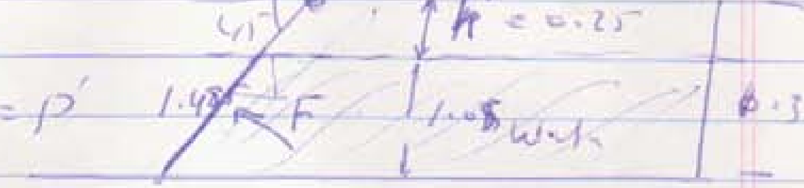
$dA = 2\, dy$

$\therefore M = \int_0^{1.3\sqrt{2}} 2y \left(\gamma \dfrac{y}{\sqrt{2}} - 2452.5\right) dy$

$= \int_0^{1.3\sqrt{2}} \left(\dfrac{2 \times 9810}{\sqrt{2}} y^2 - 4905\, y\right) dy$

$= \left[\dfrac{2 \times 9810}{3\sqrt{2}} y^3 - \dfrac{4905}{2} y^2\right]_0^{1.3\sqrt{2}} = 20.447\ kN \cdot m$

Q.68



$0 + \gamma_s R - \gamma R - \gamma \times 2 = p'$

$p' = -2452.5 \ N/m^2$

$h' = -0.25 m$ vacuum.

$F = \gamma \bar{h} A = 9810 \times \frac{1.05}{2} \times (1.485 \times 2)$

$= 15.3 \ kN$

$y_p = \bar{y} + \frac{I_G}{\bar{y}A}$

$\bar{y} \sin\theta = \bar{h}$

$\therefore \bar{y} = \frac{1.05}{2 \sin\theta} = 0.742 m$

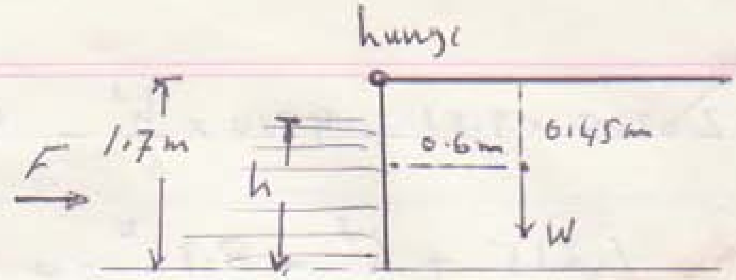
$\therefore y_p = 0.742 + \frac{2 \times (1.485)^3}{12 \times 0.742 \times 1.485 \times 2} = 0.99 m$

$M = F \left(y_p + \frac{0.25}{\sin 45} \right)$

$= 15.3 \times \left(0.99 + \frac{0.25}{\sin 45} \right)$ a = 1.34 m

$= 20.5 \ kN$

2-59



$m = 450$ kg

$W = 450 \times 9.81$ N

$F = \gamma \bar{h} A = 9810 \times \frac{h}{2} \times h \times 1 = \frac{9810}{2} h^2$

$y_p = \bar{y} + \frac{I_G}{\bar{y} A} = \frac{h}{2} + \frac{1 \times h^3}{\frac{h}{2} \times h \times 1 \times 12} = \frac{2}{3} h$

$\Sigma M = 0$ about the hinge:

$F \times arm = W \times 0.6$

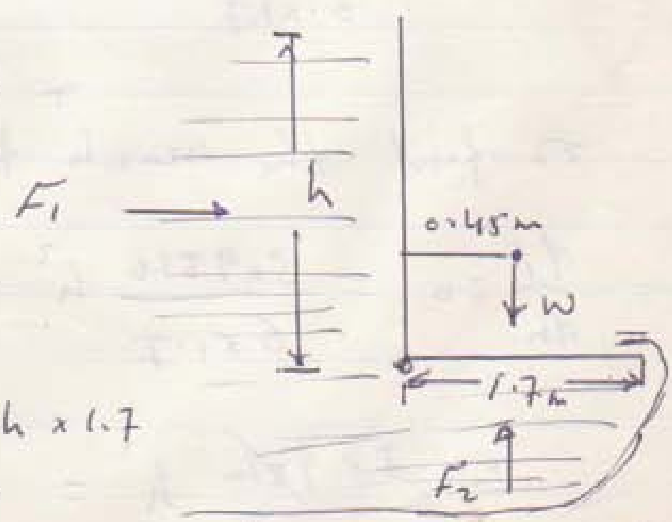
$arm = 1.7 - \frac{1}{3} h$

$\therefore \; 9810 \times \frac{h^2}{2} \left(1.7 - \frac{1}{3} h\right) = 450 \times 9.81 \times 0.6$

$h^3 - 5.1 h^2 + 1.62 = 0$

$h = 0.6$ m

2-60



$W = 450 \times 9.81$

$F_1 = \gamma \bar{h} A = \gamma \frac{h}{2} \times h \times 1$

$= \gamma \frac{h^2}{2}$

$y_{p_1} = \frac{2}{3} h$

$F_2 = \gamma h \times 1.7 \times 1 = \gamma h \times 1.7$

$\Sigma M = 0$ about the hinge

$W \times 0.45 + F_1 (h - y_p) - F_2 \times \frac{1.7}{2} = 0$

$450 \times 9.81 \times 0.45 + \gamma \frac{h^2}{2} \left(h - \frac{2}{3} h\right) - \gamma h \times \frac{1.7^2}{2} = 0$

$$202.5 \times 9.81 + 9810 \times \frac{h^3}{6} - 9810\, h^2 \times 1.45 = 0$$

$$1.215 + h^3 - 8.7h^2 = 0$$

$$h^3 - 8.7h^2 + 1.215 = 0$$

$$\therefore h = \overset{0.44}{\cancel{2.88}}\ m$$

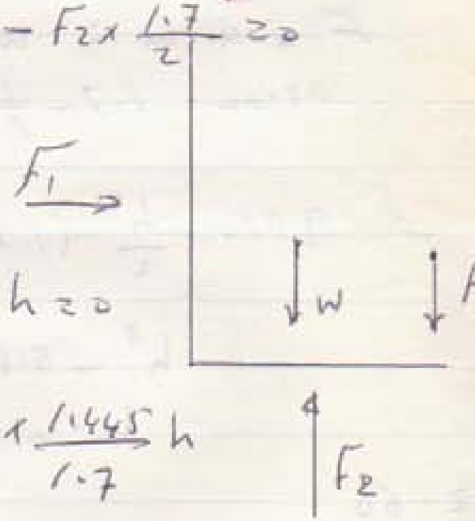
[illegible] 2.85m [illegible]

2-61

$$F_1 \times \frac{1}{3}h + W \times 0.45 + F \times 1.7 - F_2 \times \frac{1.7}{2} = 0$$

$$\frac{9810\, h^3}{6} + 202.5 \times 9.81$$

$$+ F \times 1.7 - 9810 \times 1.445\, h = 0$$



$$\therefore F = \frac{9810}{6 \times 1.7} h^3 - 9810 \times \frac{1.445}{1.7} h$$

$$+ 202.5 \times 9.81$$

To find the max. h for max. F

$$\frac{dF}{dh} = 0 = \frac{3 \times 9810}{6 \times 1.7} h^2 - \frac{9810 \times 1.445}{1.7} + 0 = 0$$

$$\therefore \frac{\cancel{3} \times \cancel{9810}}{\cancel{6}_2 \times \cancel{1.7}} h^2 = \frac{\cancel{9810} \times 1.445}{\cancel{1.7}}$$

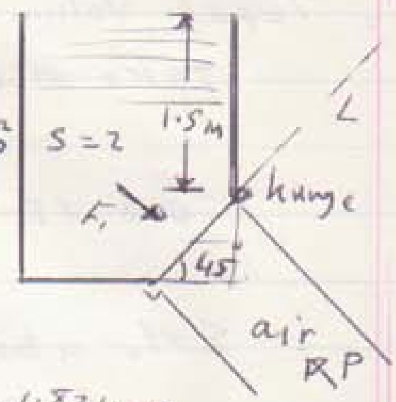
$$\boxed{h = 1.7\ m}$$

2-71 $D = 700\ mm$

$W_{gate} = 1800\ N$

$F_1 = \gamma \bar{h} A = 2 \times 9810 \times \left(\frac{0.7 \sin 45}{2} + 1.5 \right) \times \frac{\pi}{4} D^2$

$= 13.195\ kN$



$y_p = \bar{y} + \frac{I_c}{\bar{y} A}$ $\quad \bar{h} = \bar{y} \sin\theta$

$\bar{y} = 2.47\ m$

$= 2.47 + \frac{\pi r^4}{4 \times 2.47 \times \frac{\pi}{4} \times 0.7^2} = 2.4824\ m$

$F_1 \times (y_p - L) + W \times \frac{0.7}{2} \cos 45 - PA \times 0.35 = 0$

$L \sin\theta = 1.5 \quad \therefore L = 2.12$

$\therefore 13.195 \times 0.3624 + 1.8 \times 0.247$

$5.23 = P \times \frac{\pi}{4} \times 0.7^2 \times 0.35$

$\therefore P = 38.82\ kPa$

? 2-78

$F_H = P_G A = \gamma \bar{h} A$

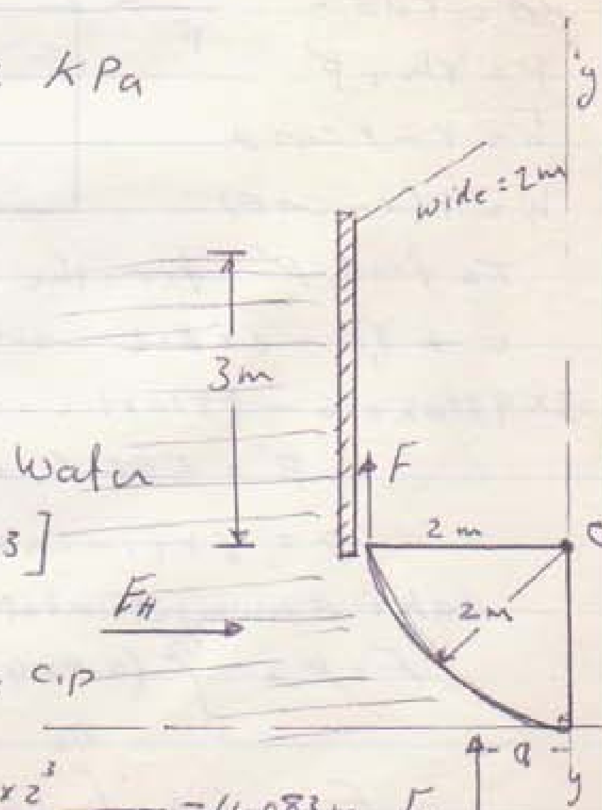
$= 9810 \times 4 \times 2 \times 2$

$= 156.96\ kN$

$F_V = \gamma V$

$= 9.81 \left[2 \times \frac{\pi r^2}{4} + r \times 2 \times 3 \right]$

$= 179.358\ kN$



To calculate F it need the c.p of the forces.

$y_p = \bar{y} + \frac{I_G}{\bar{y} A} = 4 + \frac{2 \times 2^3}{12 \times 4 \times 2 \times 2} = 4.083\ m$

Total volume $= 2\times3\times2 + \pi r^2 \times 2 \times \frac{1}{4} = 18.28\,m^3$

take moments about y-y

$$a \times 18.28 = 12\times1 + 2\pi \times \frac{4r}{3\pi}$$

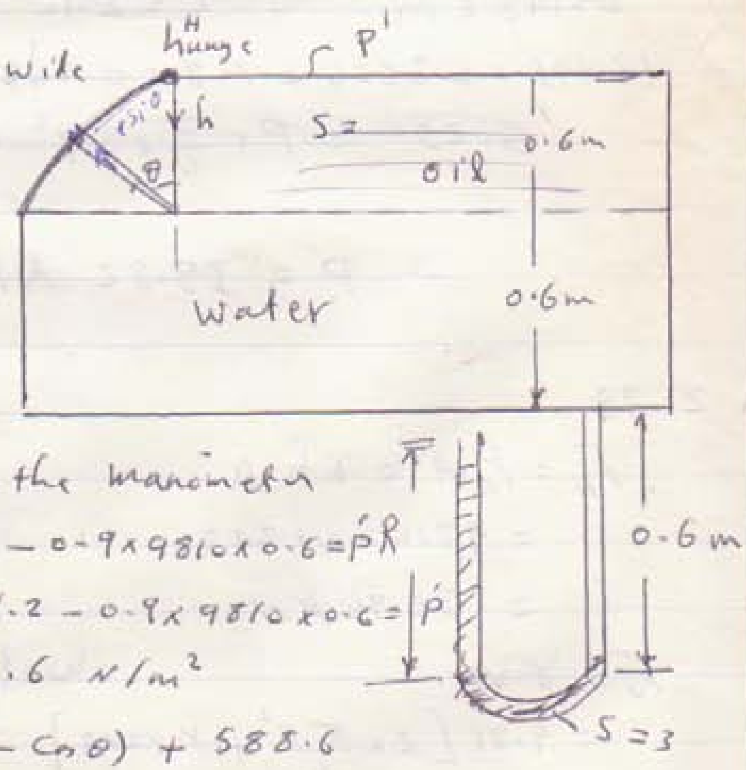
$$a = 0.948\ m$$

ΣM_o about o

$$F\times2 + F_v \times a = F_H\,(y_p - 3)$$

$$F \approx 0$$

Q. 79



P' = pressure at H

$dA = r\,d\theta \cdot L$

$p = \gamma h + p'$

$h = r - r\cos\theta$

$h = r(1-\cos\theta)$

To find p' from the manometer

$$0 + \gamma_s R - \gamma \times 1.2 - 0.9\times9810\times0.6 = p'R$$

$$3\times9810\times0.6 - 9810\times1.2 - 0.9\times9810\times0.6 = p'$$

$$\therefore p' = 588.6\ N/m^2$$

$$\therefore p = \gamma r(1-\cos\theta) + 588.6$$

take a moment about H

$$F\times X = \int_0^{\pi/2} (0.9\times9810\times0.6\,(1-\cos\theta) + 588.6)\,r\sin\theta\, r\,d\theta \cdot L$$

$$F = 1.3 \int_0^{\pi/2} (0.9\times9810\times0.6\,(1-\cos\theta) + 588.6)\,0.6\sin\theta\, d\theta$$

since $\sin\theta\cos\theta = \frac{\sin 2\theta}{2}$

$$\therefore F = 1.3 \times 0.6\left[\frac{0.9 \times 9810 \times 0.6}{2} + 588.6\right]$$

$$F = 2.5251 \text{ kN.}$$

2.80 $\quad R = 45$ cm

$\therefore P' = -3825.9 \text{ N/m}^2$

from qu. 79

$$F = Lr\left[\frac{\gamma r}{2} + p'\right)$$
$$= -918.2 \text{ N}$$

2-81 $\quad$ from Q. 79

$$F = Lr\left[\frac{\gamma r}{2} + p'\right]$$

$$p' = 0 + 3 \times 9810 R - 9810 \times 1.2 - 0.9 \times 9810 \times 0.6$$
$$= 29430R - 17069.4$$

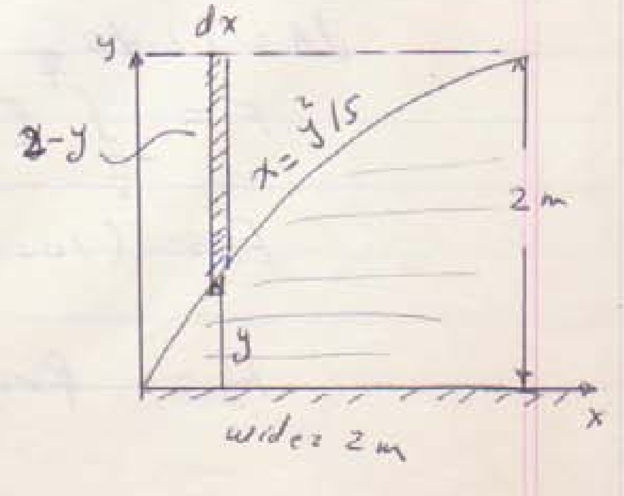
$$\therefore F = 1.3 \times 0.6\left[\frac{0.9 \times 9810 \times 0.6}{2} + 29430R - 17069.4\right]$$
$$= 0$$

$\therefore R = 0.49$ m

Q.2.82 $\quad x = \frac{y^2}{5} \quad L = 2$

for $y = 2 \quad x = 0.8$

$$F_v = \gamma L \int_0^{x_0} (2-y)\,dx$$



$$F_v = 9 \times 2 \int_0^{0.8} (2 - \sqrt{5}\, x^{1/2})\, dx$$

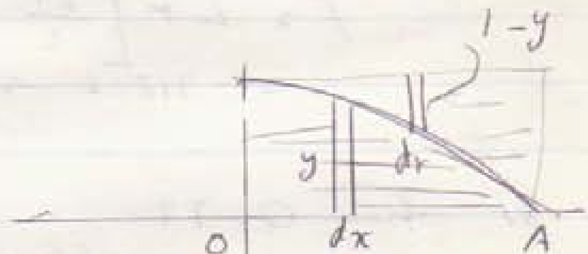
$$F_v = 9.8 \text{ kN}$$

$$F_v \bar{x} = \gamma L \int_0^{0.8} (2 - \sqrt{5}\, x^{1/2})\, x\, dx$$

$$\bar{x} = \frac{1}{9.8} \times 9 \times 2 \left[x^2 - \sqrt{5} \times \frac{2}{5} x^{5/2} \right]_0^{0.8}$$

$$\bar{x} = 0.240 \text{ m}$$

X Q.2.83



$$F = \gamma L \int_0^A (1-y)\, dx$$

$$= 9 \times L \int_0^{2\sqrt{2}} \left(1 - \frac{x^2}{8}\right) dx$$

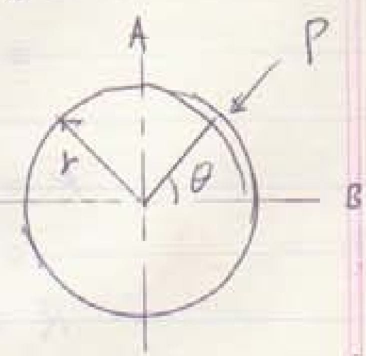
$$F = 9 \times L \left[x - \frac{x^3}{24} \right]_0^{2\sqrt{2}} = 50.92 \text{ kN} \qquad y = \frac{x^2}{8}$$

3 m wide

at $y = 1$ $\quad x = 2\sqrt{2}$

$$\cancel{F = 9 \times 3 \left[\frac{x^3}{24} \right]_0 = 25.45 \text{ kN}}$$

2.84



$$F_x = \int_A p \cos\theta \, dA$$

$$dA = r L \, d\theta$$

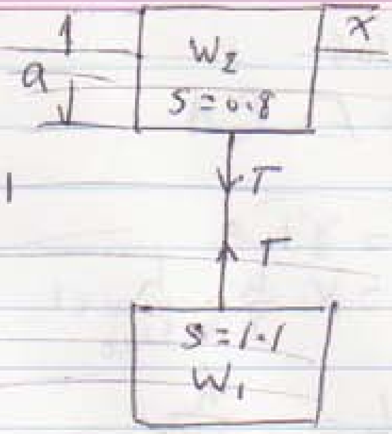
$$F = \int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \left[2P(1 - 4\sin^2\theta) + 10 \right] \cos\theta \, r L \, d\theta$$

$$F_x = \left(100 - \frac{20}{3} P\right) r$$

$F_y = 0$ from symetrical

عند التعويض في
الدالة ينتج = ٠

2.98



$T + F_{V_1} = W_1$

$T + 1 \times 9810 \times 1 = 1.1 \times 9810 \times 1$

$T = 980\ N$

als. $T + W_2 = F_{V_2}$

$980 + 0.8 \times 9810 \times 1 = 9810 \times a^2(a - x)$

since $a = 1$

$\therefore x = 0.1\ m = 100\ mm$

2.105

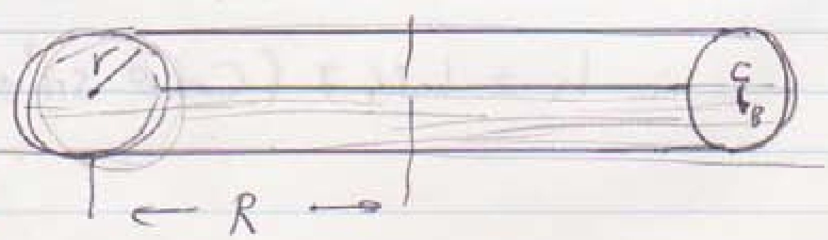
$GB = \frac{4r}{3\pi} = \frac{4 \times 0.3}{3\pi} = 0.127\ m$

$MB = \frac{I}{V} = \frac{\pi(R+r)^4/4 - \pi(R-r)^4/4}{\cancel{\frac{1}{2}}\pi r^2 \cdot 2\pi R}$

$= \frac{\cancel{(R+r)^2[(R+r)^2 -}}{4\pi R r^2}$

$= \frac{(1.3)^4 - (0.7)^4}{4 \times \pi \times 1 \times (0.3)^2} = 2.313$

$\therefore MG = MB - GB = 2.186\ m$

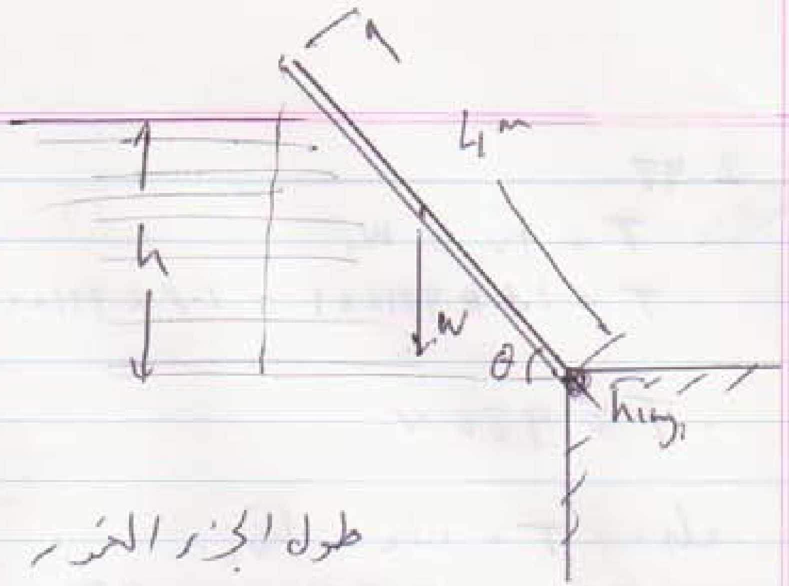


2.106

a) $F = P_G A$

$= \gamma \bar{h} A$

$= \gamma \frac{h}{2} \cdot \frac{h}{\sin\theta} \times 1$



$L = \frac{h}{\sin\theta}$ طول الجزء المغمور

$y_p = \bar{y} + \frac{I_G}{\bar{y}A}$ $\qquad \bar{y} = \frac{1}{2}\frac{h}{\sin\theta}$ $\qquad I_G = \frac{bh^3}{12}$

$\therefore y_p = \frac{h}{2\sin\theta} + \frac{1 \times (h/\sin\theta)^3}{\cancel{12}_6 \times \frac{h}{\cancel{2}\sin\theta} \times \frac{h}{\sin\theta} \times 1}$

$= \frac{2}{3}\frac{h}{\sin\theta}$

The arm take from $O = \frac{1}{3}\frac{h}{\sin\theta}$

$\therefore \Sigma M$ about $O = 0$ $\circlearrowright +$

$F \times \frac{1}{3}\frac{h}{\sin\theta} = 2000 \times 2 \times \cos\theta$

$\frac{\gamma h^2}{2\sin\theta} \times \frac{1}{3}\frac{h}{\sin\theta} = 4000 \cos\theta$

$\therefore h = 1.347 (\cos\theta \cdot \sin^2\theta)^{1/3}$

b) from (a) $\Sigma M = \dfrac{\gamma h^3}{6\sin^2\theta} - 4000\cos\theta$

$$\frac{\partial M}{\partial \theta} = -\frac{\gamma h^3}{3}\csc^3\cos\theta + 4000\sin\theta$$

substituting for h

$$\frac{\partial M}{\partial \theta} = -\frac{\gamma}{3}\left(2.45\cos\theta\sin^2\theta\right)\csc^3\theta\cos\theta + 4000\sin\theta$$

$$= -\frac{\gamma}{3} \times 2.45\cos\theta\sin^2\theta \times \frac{1}{\sin^3\theta}\cos\theta + 4000\sin\theta$$

$$= -8000\frac{\cos^2\theta}{\sin\theta} + 4000\sin\theta$$

$$= 4000\left(\sin\theta - \frac{2\cos^2\theta}{\sin\theta}\right)$$

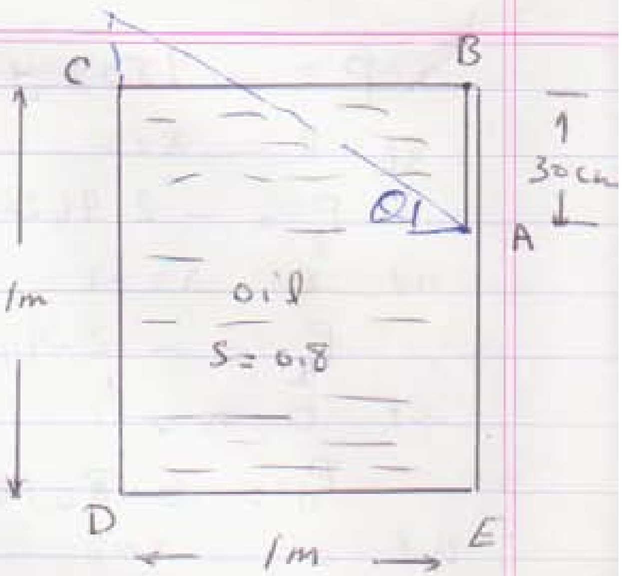
$\dfrac{\partial M}{\partial \theta} < 0$ stable

$$\therefore \sin\theta < \frac{2\cos^2\theta}{\sin\theta}$$

or $\tan^{-1}\sqrt{2} > \theta$ $\therefore \theta = 54.4^\circ$

3

imaginary line $\theta = 21.7^\circ$



Q.110

find P_B, P_c, P_D, P_E

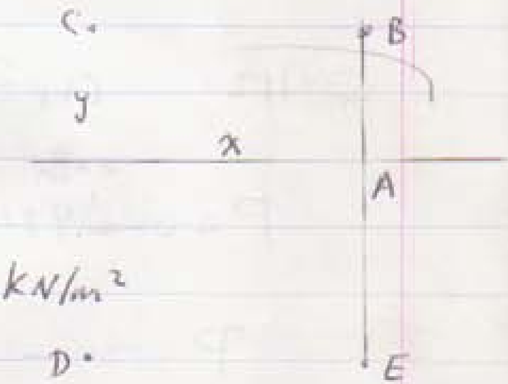
$a_x = 3.9\ m/s^2 \quad a_y = 0$

since The tanke filled and

$P_A = P_{atm}$

$P = P_o - \gamma \frac{a_x}{g} x - \gamma (1 + \frac{a_y}{g}) y$

$\therefore P = 0 - 0.8 \times 9810 \times \frac{3.9}{9.81} x - 0.8 \times 9810\ (1 + \frac{0}{g}) y$



$P = -3120\ x - 7848\ y$

at point B $x = 0$, $y = 0.3$

$\therefore P_B = 0 - 7848 \times 0.3 = -2.354\ kN/m^2$

at C $\quad x = -1 \quad y = 0.3$

$\therefore P_c = 0.7656\ kPa$

at D $\quad x = -1 \quad y = -0.7$

$P_D = 8.614\ kPa$

at E $\quad x = 0 \quad y = -0.7$

$P_E = 5.494\ kPa$

Q 2.111 $\quad a_x = 0 \quad a_y = 2.45\ m/s^2$ find P_B, P_c, P_D, P_E

$\therefore P = 0 - 0.8 \times 9810 \times \frac{0}{9.81} x - 0.8 \times 9810 (1 + \frac{2.45}{9.81}) y$

$\therefore P = -9808\,y$

at B $\quad x = 0 \quad y = 0.3$

$P_B = -2.9424$ KPa

at C $\quad x = -1 \quad y = 0.3$

$P_C = -2.9424$ kPa

at D $\quad x = -1 \quad y = -0.7$

$P_D = 6.8656$ KPa

at E $\quad x = 0 \quad y = -0.7$

$P_E = 6.8656$ KPa.

Q.112 $\quad a_x = 2.45\ m/s^2 \quad a_y = 4.902\ m/s^2$

$$P = 0 - 0.8 \times 9810 \times \frac{2.45}{9.81} \times X - 0.8 \times 9810 \left(1 + \frac{4.902}{9.81}\right) y$$

$$P = -1960\,X - 11772\,y$$

at B $\quad x = 0 \quad y = 0.3$

$P_B = -3.532$ KPa

at C $\quad x = -1 \quad y = 0.3 \qquad P_c = -1.572$ KPa

at D $\quad x = -1 \quad y = -0.7 \qquad P_D = 10.2$ kPa

at E $\quad x = 0 \quad y = -0.7 \qquad P_E = 8.24$ kPa

Q. 2.113 find P_A, P_B, P_C

let the origin at E

$\tan\theta = \frac{a_x}{a_y + g} = \frac{9.806}{0+9.806} = 1$ the water pass Point A $\theta > 25°$

$\theta = 45°$ $\tan\theta = \frac{h}{x}$ $\therefore x\tan\theta = h$

Volume of space initial = Volume of new space final

$0.3 \times 1.3 \times 1 = x \cdot \frac{h}{2} = x \cdot \frac{x\tan\theta}{2}$

$\therefore x = 0.883176$ m

$h = 0.883176$ m

also $\tan\theta = \frac{h+s}{1.3} = 1$

$\therefore s = 1.3 - 0.883176 = 0.416824$ m

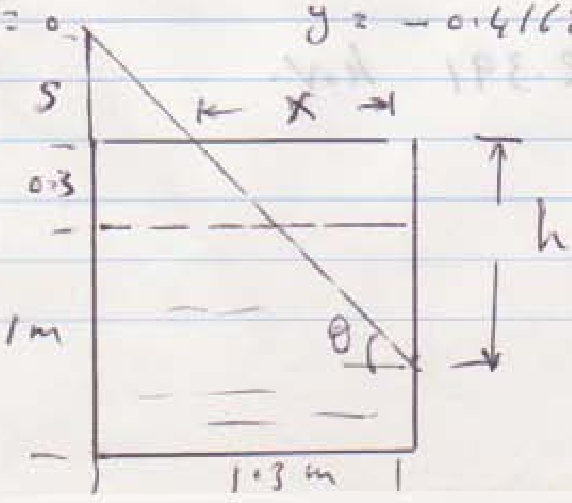
$\therefore P = P_0 - \gamma \frac{a_x}{g} x - \gamma\left(1 + \frac{a_y}{g}\right) y$

$P = -9810\,x - 9810\,y$

at A $x = -1.3$ $y = 0.883176$ $\therefore P_A = 4.09$ kPa

at B $x = -1.3$ $y = -0.416824$ $\therefore P_B = 16.842$ kPa

at C $x = 0$ $y = -0.416824$ $P_C = 4.09$ kPa.



2.135

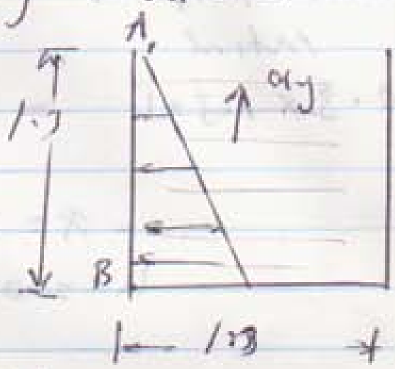
$P = \gamma\left(1 + \frac{a_y}{g}\right) h \qquad h = -y$

$P = 9810\left(1 + \frac{2.45}{9.81}\right) 1.3 = 15.94$ kPa.

$F = \gamma \bar{h} . A$

$F = \cancel{9810}\left(\frac{P_B + P_A}{2}\right) 1.3 \times 1.3$

$= 13.47$ kN.



2.136 $a_y = 2.45\ m/s^2 \downarrow$

$P = 0.65 \times 9810\left(1 - \frac{2.45}{9.81}\right) \times 1$

$P = 4.7823$ kPa

$F = \left(\frac{P_A + P_B}{2}\right) 1 \times 1$

or $F = \gamma \bar{h} A \qquad \bar{h} = \frac{P}{\gamma} + \frac{1}{2}$

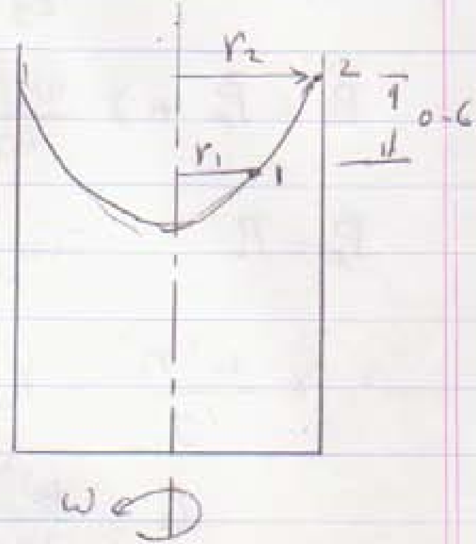
$F = 2.391$ kN.

Q.2.119 $P_x = P_y = P_z$ استقلالية الضغط لنقطة

120, 121 2 ش

Q.122

$r_1 = 0.6\ m \qquad r_2 = 1.2\ m$



$$P_1 = P_o + \gamma \frac{\omega^2 r_1^2}{2g} - \gamma y$$

$$P_2 = P_o + \gamma \frac{\omega^2 r_2^2}{2g} - \gamma (y + 0.6)$$

since $P_1 = P_2$

$$\therefore \gamma \frac{\omega^2 r_1^2}{2g} - \cancel{\gamma y} = \gamma \frac{\omega^2 r_2^2}{2g} - \cancel{\gamma y} - 0.6\gamma$$

$$0.6 = \frac{\omega^2}{2g}\left(r_2^2 - r_1^2\right) = \frac{\omega^2}{2 \times 9.81}\left((1.2)^2 - (0.6)^2\right)$$

$$\omega = 3.3\ rad/s = \frac{2\pi N}{60}$$

$$\therefore N = 31.5\ rpm$$

also [illegible]

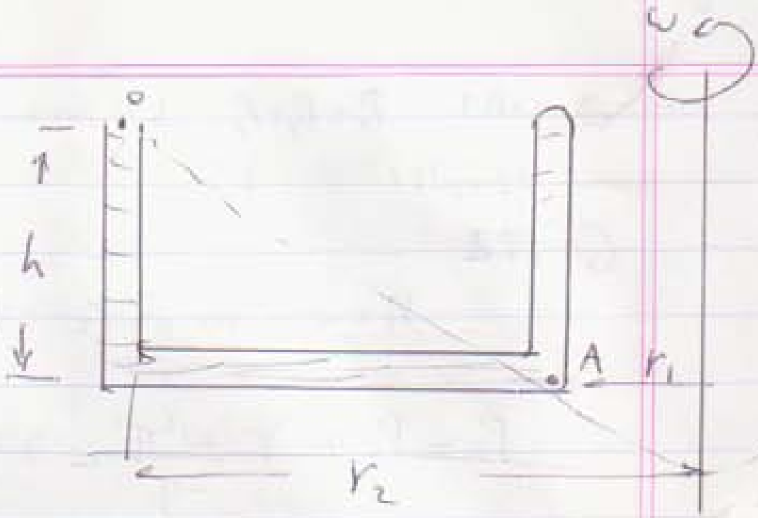
$$h = \frac{\omega^2 r^2}{2g} \qquad \therefore h_1 = \frac{\omega^2 r_1^2}{2g} \qquad h_2 = \frac{\omega^2 r_2^2}{2g}$$

$$h_2 = h_1 + 0.6$$

$$\therefore 0.6 = \frac{\omega^2}{2g}\left(r_2^2 - r_1^2\right) \Rightarrow \omega = 3.3\ rad/s$$

$$N = 31.5\ rpm$$

2.123



$$P_A = P_o + \gamma \frac{\omega^2 r_1^2}{2g} - \gamma y$$

$$P_o = P_o + \gamma \frac{\omega^2 r_2^2}{2g} - \gamma(y+h)$$

$P_A = P_o$ zero gage الثنين

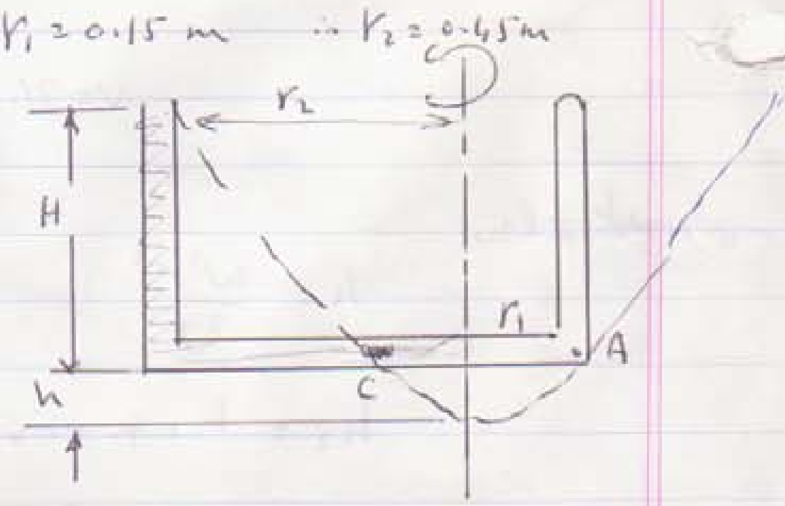
$$\therefore \cancel{\gamma} \frac{\omega^2 r_1^2}{2g} - \cancel{\gamma y} = \gamma \frac{\omega^2 r_2^2}{2g} - \cancel{\gamma y} - \gamma h$$

$$h = \frac{\omega^2}{2g}(r_2^2 - r_1^2) = \frac{\omega^2}{2 \times 9.81}((0.75)^2 - (0.15)^2)$$

$$\therefore \omega = \sqrt{\frac{0.3 \times 2 \times 9.81}{0.54}} = 3.3 \text{ rad/s}$$

$$= \frac{2\pi N}{60} \quad \therefore N = 31.5 \text{ rpm}$$

2.124 from Symetrical $r_1 = 0.15$ m $\therefore r_2 = 0.45$m



$$H + h = \frac{\omega^2 r_2^2}{2g} \quad \text{--- (1)}$$

$$h = \frac{\omega^2 r_1^2}{2g} \quad \text{--- (2)}$$

بطرح

$$H = \frac{\omega^2 (r_2^2 - r_1^2)}{2g}$$

$$\therefore \omega = \sqrt{\frac{0.3 \times 2 \times 9.81}{(0.45)^2 - (0.15)^2}} = 5.7 \text{ rad/s}$$