i) $P_c = P_A - \rho_1 g(20\times10^{-2}) + \rho_4 g(42\times10^{-2})$

$+ \rho_2 g h$

$8000 = 1000 + 9.81(-700(0.2) + 1200(0.42)$

$+ 2000h)$

$3429.16 = 1962h$

$h = 0.1747787971\,m$

$\approx 17.5\,cm$

ii) Let O be the point above C by height h.

$P_O = P_C - \rho_2 g h$

$= 8000 - 2000\times9.81\times0.1747787971$

$= 4570.84\,Pa$

$P_B = P_O - \rho_4 g(16+15)\times10^{-2}$

$= 4570.84 - 1200\times9.81(0.31)$

$= 921.52\,Pa$

2) $F_{right} = p\,dz$

$$F_{btm} = \left(p + \rho g \frac{dz}{2}\right) dy$$

$$F_{top} = \left(p - \rho g \frac{dz}{2}\right) dy$$

$$\partial p = \frac{F_{btm} - F_{top} - W}{dz\,dy}$$

$$= \frac{\cancel{dy}\left(\cancel{p} + \rho g \frac{dz}{2} - \cancel{p} + \rho g \frac{dz}{2}\right) - \gamma\, dz\, dy}{\rho g \cancel{dz} - \gamma \cancel{dz}\; dz\, dy}$$

$$= \rho g - \gamma$$

$$\frac{\partial p}{\partial z} = \frac{\rho g - \gamma}{dz}$$

3:) $F_{H_L} = 1000(0.4 \times 1) + 800 \times 9.81 \times 0.1 \times 0.2 \times 1$

$= 556.96N$

$F_{H_R} = 1000 \times 9.81 \times 0.2 \times 0.4 \times 1$

$= 784.8N$

$F_H = 784.8 - 556.96$

$= 227.84N$

ii) Taking moments about the bottom of the gate,

$F_H y_r = F_{air}(0.2) + F_1\left(\frac{0.2}{3}\right) - F_2\left(\frac{0.4}{3}\right)$

$-227.84\, y_r = 1000 \times 0.4 \times 1 \times 0.2 + 800 \times 9.81 \times 0.1 \times \frac{0.2^2}{3} - 784.8\left(\frac{0.4}{3}\right)$

$-227.84 y_r = -14.176$

$y_r = 0.062219910112$

$\approx 6.22\,cm$

iii) $F_v = \rho g V$

$= 1000 \times 9.81 \times \frac{1}{2}\pi(0.1)^2 \times 1$

$= 154.0951197\,N$

$\approx 154.1\,N$

iv) $x_0 = \frac{4r}{3\pi}$

$= \frac{4(0.1)}{3\pi}$

$= 0.04244131816\,m$

$\approx 4.24\,cm$

v) $M = 227.84 \times (0.2 - 0.06221910112) - 154.0951197\left(\frac{4(0.1)}{3\pi}\right)$

$= 24.852\,Nm$