Q1. (A) Streamlines are not curved

(B) $\tau_1 = \mu \frac{du}{dy} = \mu \frac{V_1}{\delta} = \tau$

$\tau_2 = 2\mu \frac{du}{dy} = 2\mu \frac{V_1}{\delta} = \boxed{2\tau}$

(C) $\rho = \frac{M}{V}$

Mass and Volume both constant

$\therefore$ ρ constant

(Pressure changes)

$\Rightarrow$ **The same as at T_1**

(D) Specific Weight $\gamma = \rho g$ ← changes

(E) $F_{eff_1} = \gamma h_{c_1} A = \gamma \left(\frac{h}{2}\right) h w = \frac{1}{2} w \gamma h^2$

$F_{eff_2} = \gamma h_{c_2} A = \gamma (h)(2hw) = 2 w \gamma h^2$

$\Rightarrow F_{eff_2} = 4 F_{eff_1}$ $\boxed{4F}$

Q2,

$$[h] = \frac{[\text{Energy}]}{[\text{Weight}]} = \frac{M L^2 T^{-2}}{M L T^{-2}} = L$$

Regime 1 $\left[\frac{D^4}{d^4} \frac{v^2}{2g}\right] = \frac{L^4}{L^4} \frac{L^2 T^{-2}}{L T^{-2}} = L$

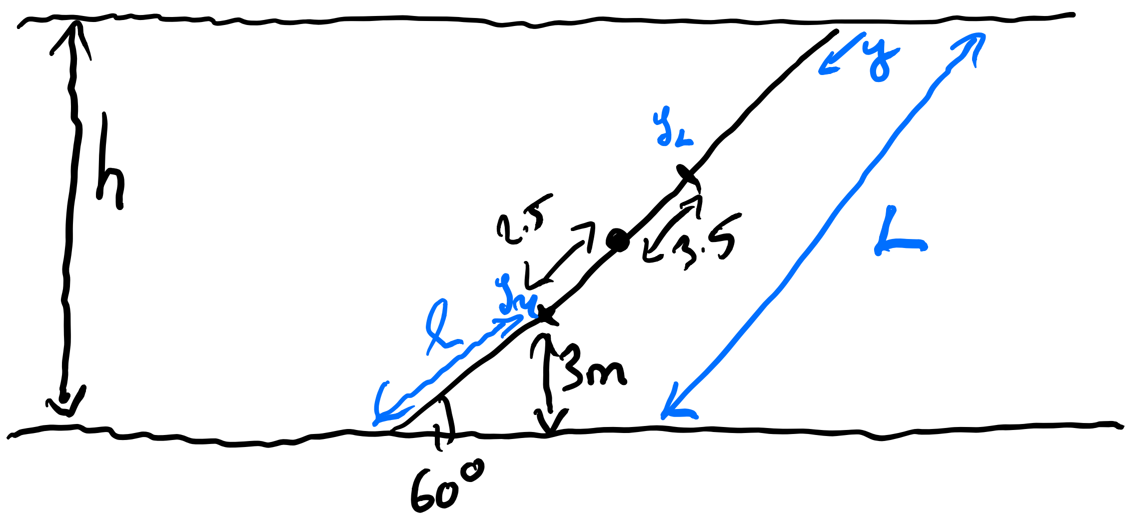
⇒ constant 0.04 has no units
Can be used in any unit system

Regime 2 $\left[\frac{D^4}{d^4} \frac{v^3}{2g}\right] = \frac{L^4}{L^4} \frac{L^3 T^{-3}}{L T^{-2}} = L^2 T^{-1}$

⇒ constant 0.7 has units $[L^{-1} T]$

⇒ NOT VALID IN ANY SYSTEM

Q3 //



$$h = L \sin 60°$$

$$l = \frac{3}{\sin 60°} \approx 3.5\,m$$

$$y_{eff} = \frac{\int_{y_l}^{y_u} y^2 dy}{\int_{y_l}^{y_u} y\, dy} = \frac{2}{3} \frac{y_u^3 - y_l^3}{y_u^2 - y_l^2}$$

$$y_u = L - l = L - 3.5$$

$$y_l = L - l - 6 = L - 9.5$$

$$\therefore \quad y_{eff} = \frac{2}{3} \frac{(L-3.5)^3 - (L-9.5)^3}{(L-3.5)^2 - (L-9.5)^2}$$

Also $y_{eff} = L - l - 2.5 = L - 6$

(we want to know when it acts on the hinge)

Setting these two expressions for y_{eff} equal

$$\frac{2}{3}\,\frac{18L^2 - 234L + 814.5}{12L - 78} = L - 6$$

$$18L^2 - 234L + 814.5 = 18L^2 - 225L + 702$$

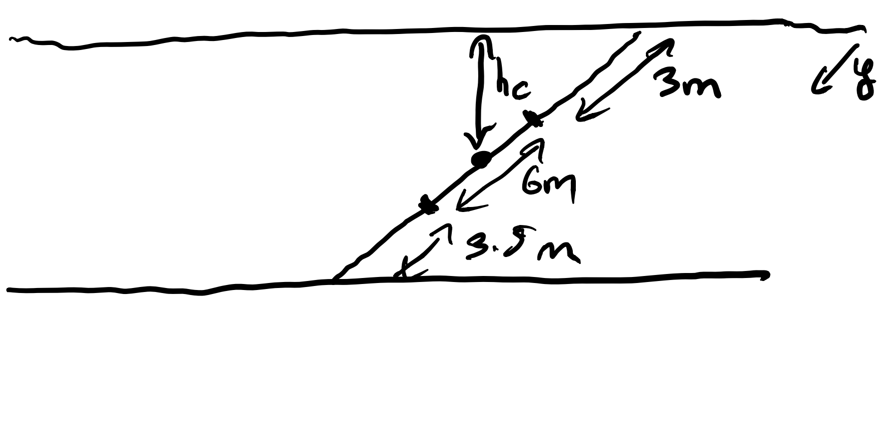
$$112.5 = 9L \Rightarrow \boxed{L = 12.5\,m}$$

$$h = L \sin 60^\circ \Rightarrow h = 10.8\,m$$

$$F_{eff} = \gamma h_c A$$

The centroid is at the midpoint of the plate

$$\Rightarrow y_c = 3 + 3 = 6\,m$$



$y_c = 6m \quad \Rightarrow h_c = y_c \sin 60^\circ$

$= 5.2\,m$

$\therefore F_{eff} = \gamma h_c A$

$= (10000)(5.2)(4 \times 6)$

$= 1248\ kN$

Height h does not change with density

$\Rightarrow y_{eff}$ does not depend on density

However the size of the force will be less.

Q4// $P_1 + \frac{1}{2}\rho v_1^2 + \rho g z_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g z_2$

$P_1 = 5\rho g$ (manometer equation)

$P_2 = 0$ (free jet)

$V_2 = 6$ m/s

$v_1 = ?$

$z_1 = 0$

$z_2 = 4$

$\therefore \quad 5\rho g + \frac{1}{2}\rho v_1^2 + 0 = 0 + \frac{1}{2}\rho 36 + 4\rho g$

$\therefore \quad v_1^2 = 36 - 2g = 36 - 20 = 16$

$\boxed{v_1 = 4 \text{ m/s}}$

Continuity $v_1 A_1 = v_2 A_2 \Rightarrow v_1 \frac{\pi}{4} D_1^2 = v_2 \frac{\pi}{4} D_2^2$

$\Rightarrow D_2 = \left(\frac{v_1}{v_2}\right)^{1/2} D_1$

$= \left(\frac{2}{3}\right)^{1/2} (0.05) = 4.08 \times 10^{-2}$ m

$= \boxed{4.1 \text{ cm}}$