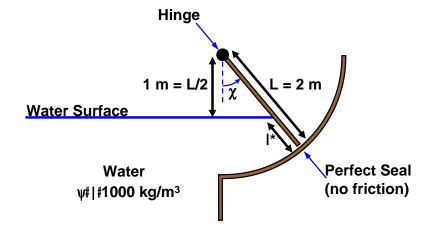## Solution to Problem 104B

The angle of repose of the plate can be found by equating the moment due to the weight of the plate to the moment due to

the pressure in the fluid. From the geometry, the submerged length of the plate is:

$$l^\star = L\left(1 - \frac{1}{2\cos\theta}\right)$$

Moment due to the hydrostatic pressure is:

$$
\begin{aligned}
M_H &= \int_0^{l^\star} \rho g y \cos\theta \left(\frac{L}{2\cos\theta} + y\right) dy \\
&= \rho g \left[\frac{L^3}{4}\left(1 - \frac{1}{2\cos\theta}\right)^2 + \frac{L^3}{3}\left(1 - \frac{1}{2\cos\theta}\right)^3 \cos\theta\right] \\
&= \frac{\rho g L^3}{3}\left(1 - \frac{1}{2\cos\theta}\right)^2 \left(\frac{1}{4} + \cos\theta\right)
\end{aligned}
$$

The moment due to the weight of the gate is:

$$M_W = \frac{1}{2}MgL\sin\theta$$

Equating these moments leads to:

$$\frac{3}{16}\sin\theta = \left(\frac{1}{4} + \cos\theta\right)\left(1 - \frac{1}{2\cos\theta}\right)^2$$

The angle of repose can be found by solving this equation be trial and error. The answer is $\theta = 40.19°$.