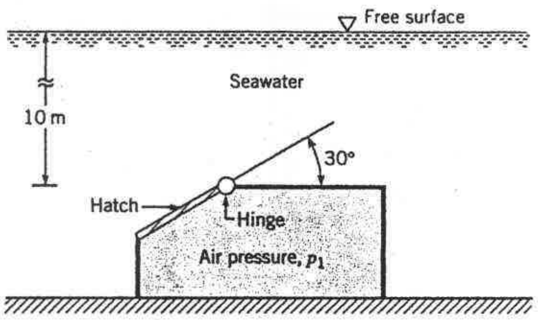
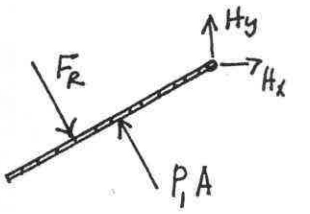
2.82

2.82 A structure is attached to the ocean floor as shown in Fig. P2.82. A 2-m-diameter hatch is located in an inclined wall and hinged on one edge. Determine the minimum air pressure, p_1, within the container to open the hatch. Neglect the weight of the hatch and friction in the hinge.



■ FIGURE P2.82

$F_R = \gamma h_c A$ where $h_c = 10\,m + \frac{1}{2}(2m)\sin 30°$
$= 10.5\,m$



Thus,

$$F_R = \left(10.1\times10^3\,\frac{N}{m^3}\right)(10.5\,m)\left(\frac{\pi}{4}\right)(2\,m)^2$$
$$= 3.33\times10^5\,N$$

To locate F_R,

$$y_R = \frac{I_{xc}}{y_c A} + y_c \quad \text{where} \quad y_c = \frac{10\,m}{\sin 30°} + 1\,m = 21\,m$$

so that

$$y_R = \frac{\left(\frac{\pi}{4}\right)(1m)^4}{(21m)(\pi)(1m)^2} + 21\,m = 21.012\,m$$

For equilibrium,

$$\Sigma M_H = 0$$

so that

$$F_R\,(21.012m - 20\,m) = p_1(\pi)(1m)^2(1m)$$

and

$$p_1 = \frac{(3.33\times10^5\,N)(1.012\,m)}{\pi\,(1m)^2(1m)} = \underline{\underline{107\,kPa}}$$