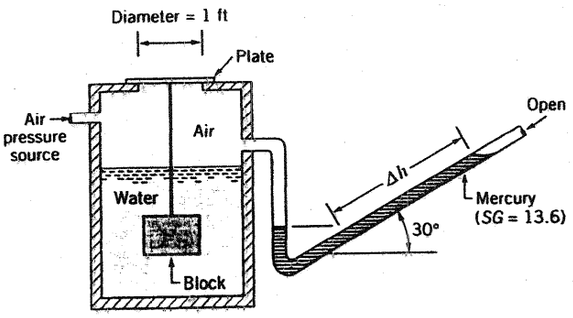
2.88

2.88 A plate of negligible weight closes a 1-ft diameter hole in a tank containing air and water as shown in Fig. P2.88. A block of concrete (specific weight = 150 lb/ft^3), having a volume of 1.5 ft^3, is suspended from the plate and is completely immersed in the water. As the air pressure is increased the differential reading, Δh, on the inclined-tube mercury manometer increases. Determine Δh just before the plate starts to lift off the hole. The weight of the air has a negligible effect on the manometer reading.



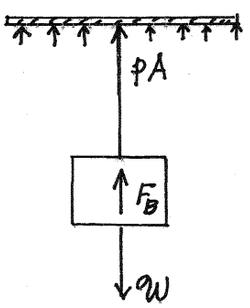
■ FIGURE P2.88

For equilibrium,

$$\Sigma F_{vertical} = 0$$

So that

$$W = pA + F_B$$



where:

W ~ weight of concrete
p ~ air pressure
A ~ area of plate
F_B ~ b

Thus,

$$(150\ \tfrac{lb}{ft^3})(1.5\ ft^3) = p\left(\tfrac{\pi}{4}\right)(1\ ft)^2 + (62.4\ \tfrac{lb}{ft^3})(1.5\ ft^3)$$

So that

$$p = 167\ \tfrac{lb}{ft^2}$$

The manometer equation is

$$p = \gamma_{Hg}\,\Delta h \sin 30^\circ$$

So that

$$\Delta h = \frac{p}{\gamma_{Hg} \sin 30^\circ}$$

$$= \frac{167\ \frac{lb}{ft^2}}{(847\ \frac{lb}{ft^3}) \sin 30^\circ} = \underline{0.394\ ft}$$