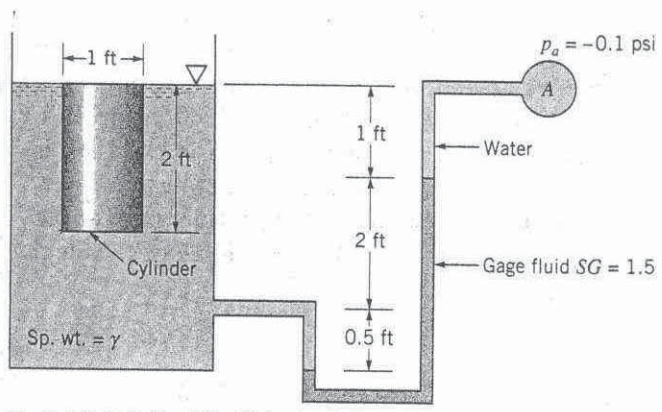
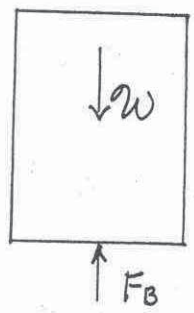
2.142

2.142 A 1-ft-diameter, 2-ft-long cylinder floats in an open tank containing a liquid having a specific weight γ. A U-tube manometer is connected to the tank as shown in Fig. P2.142. When the pressure in pipe A is 0.1 psi below atmospheric pressure, the various fluid levels are as shown. Determine the weight of the cylinder. Note that the top of the cylinder is flush with the fluid surface.



■ FIGURE P2.142

From a free-body-diagram of the cylinder



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

so that

$$W = F_B = \gamma\left(\frac{\pi}{4}\right)(1\,ft)^2(2\,ft)$$

$$= \frac{\pi\gamma}{2} \qquad (1)$$

A manometer equation gives,

$$\gamma(3.5\,ft) - (SG)(\gamma_{H_2O})(2.5\,ft) - \gamma_{H_2O}(1\,ft) = p_A$$

so that

$$\gamma(3.5\,ft) - (1.5)\left(62.4\,\frac{lb}{ft^3}\right)(2.5\,ft) - \left(62.4\,\frac{lb}{ft^3}\right)(1\,ft) = \left(-0.1\,\frac{lb}{in^2}\right)\left(\frac{144\,in^2}{ft^2}\right)$$

and

$$\gamma = 80.6\,\frac{lb}{ft^3}$$

Thus, from Eq. (1)

$$W = \left(\frac{\pi}{2}\,ft^3\right)\left(80.6\,\frac{lb}{ft^3}\right) = \underline{\underline{127\,lb}}$$