2.99

2.99 A tank of cross-sectional area A is filled with a liquid of specific weight γ_1 as shown in Fig. P2.99*a*. Show that when a cylinder of specific weight γ_2 and volume V is floated in the liquid (see Fig. P2.99*b*), the liquid level rises by an amount $\Delta h = (\gamma_2/\gamma_1)\,\forall/A$.

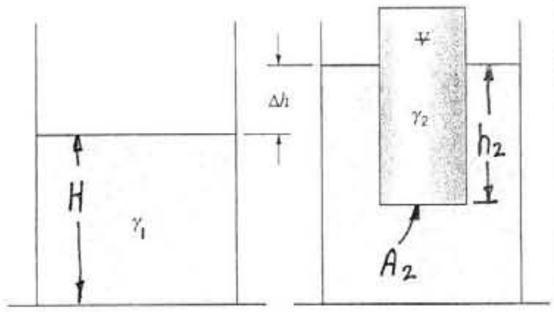

FIGURE P2.99

W = weight of cylinder = $\gamma_2 \forall$

For equilibrium,

W = weight of liquid displaced = $\gamma_1 h_2 A_2 = \gamma_1 \forall_2$ where $\forall_2 = h_2 A_2$

Thus,

$\gamma_2 \forall = \gamma_1 \forall_2$, or

$$\forall_2 = \frac{\gamma_2}{\gamma_1} \forall$$

However, the final volume within the tank is equal to the initial volume plus the volume, $\forall_2$, of the cylinder that is submerged. That is,

$$(H + \Delta h)A = HA + \forall_2$$

or

$$\Delta h = \frac{\forall_2}{A} = \underline{\underline{\frac{\gamma_2}{\gamma_1}\frac{\forall}{A}}}$$