5.26

5.26 Estimate the time required to fill with water a cone-shaped container (see Fig. P5.26) 5 ft high and 5 ft across at the top if the filling rate is 20 gal/min.

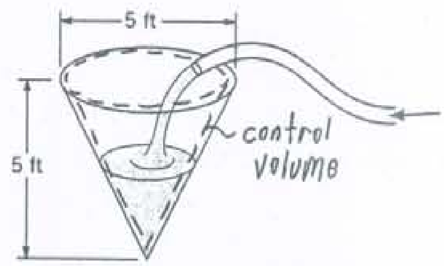

FIGURE P5.26

From application of the conservation of mass principle to the control volume shown in the figure we have

$$\frac{\partial}{\partial t}\int_{cv} \rho \, d\forall + \int_{cs} \rho \vec{V} \cdot \hat{n} \, dA = 0$$

For incompressible flow

$$\frac{\partial \forall}{\partial t} - Q = 0$$

or

$$\int_0^{\forall} d\forall = Q \int_0^{t} dt$$

Thus

$$t = \frac{\forall}{Q} = \frac{\pi D^2 h}{12\, Q} = \frac{\pi (5 \text{ ft})^2 (5 \text{ ft}) \left(1728 \frac{\text{in.}^3}{\text{ft}^3}\right)}{(12)\left(20 \frac{\text{gal}}{\text{min}}\right)\left(231 \frac{\text{in.}^3}{\text{gal}}\right)}$$

and

$$t = \underline{\underline{12.2 \text{ min}}}$$