Solution 1.21

A pool is to be filled with water using a hose. Based on unit considerations, a relation is to be obtained for the volume of the pool.

Assumptions Water is an incompressible substance and the average flow velocity is constant.

Analysis The pool volume depends on the filling time, the cross-sectional area which depends on hose diameter, and flow velocity. Also, we know that the unit of volume is m^3. Therefore, the independent quantities should be arranged such that we end up with the unit of seconds. Putting the given information into perspective, we have

$$V \text{ [m}^3\text{]} \quad \text{is a function of} \quad t \text{ [s], } D \text{ [m], and } V \text{ [m/s}\}$$

It is obvious that the only way to end up with the unit "m^3" for volume is to multiply the quantities t and V with the square of D. Therefore, the desired relation is

$$V = CD^2Vt$$

where the constant of proportionality is obtained for a round hose, namely, $C = \pi/4$ so that $V = (\pi D^2/4)Vt$.

Discussion Note that the values of dimensionless constants of proportionality cannot be determined with this approach.