7.23 Assume that the drag on a small sphere placed in a rapidly moving stream of fluid depends on the fluid density but not the fluid viscosity. Use dimensional analysis to determine how the drag is affected if the velocity of the fluid is doubled.

Let: \( \text{drag} = \rho \frac{d^2}{2} F \)  
\( \text{sphere diameter} = d = L \)  
\( \text{fluid velocity} = V = LT^{-1} \)  
\( \text{density of fluid} = \rho = ML^{-3}T^{-2} \)

Thus, \( \rho \frac{d^2}{2} F = f(d, V, \rho) \)

From the pi theorem, \( 4 - 3 = 1 \) pi term required.

By inspection:
\[
T_1 = \frac{\rho d}{V^2 d^2} = \frac{F}{(L^{-3}T^{-2})(L^{-1})^2 (L)^2} = F L^0 T^{-6} \]

Check using MLT:
\[
\frac{\rho d}{V^2 d^2} = \frac{ML^{-2}}{(ML^{-3})(L^{-1})^2 (L)^2} = M^0 L^0 T^{-6} \therefore \text{ok}
\]

Since there is only 1 pi term, it follows that
\[
\frac{\rho d}{V^2 d^2} = C
\]
where \( C \) is a constant. Thus,
\[
\rho d = C \rho V^2 d^2
\]
and if \( V \) is doubled \( \rho \) will increase by a factor of \( 4 \).