

Solution to Problem 109C

The characteristic parameters and variables of this assignment are given in table 1.

| Parameter | Units |
|-------------------------|-------------|
| length L | m |
| dynamic viscosity μ | kg/ms |
| density ρ | kg/m^3 |
| velocity U | m/s |
| force | $kg\ m/s^2$ |

Table 1: Units.

By combining the units given in table 1, it transpires that there are two possible combinations which yield the units of force. The parameter related to the viscous force F_v is:

$$P_1 = U\mu L = \left[\frac{m}{s}\right] \left[\frac{kg}{ms}\right] [m] = \left[\frac{kg\ m}{s^2}\right]$$

while the parameter related to the inertial force F_i is:

$$P_2 = U^2\rho L^2 = \left[\frac{m}{s}\right]^2 \left[\frac{kg}{m^3}\right] [m]^2 = \left[\frac{kg\ m}{s^2}\right]$$

By dividing the typical inertial force by the viscous force, the Reynolds number is obtained:

$$Re = \frac{P_2}{P_1} = \frac{U^2\rho L^2}{U\mu L} = \frac{\rho UL}{\mu} = \frac{UL}{\nu}$$

with kinematic viscosity $\nu = \mu/\rho$.