7.43 The drag characteristics of a torpedo are to be studied in a water tunnel using a 1:5 scale model. The tunnel operates with freshwater at 20 °C, whereas the prototype torpedo is to be used in seawater at 15.6 °C. To correctly simulate the behavior of the prototype moving with a velocity of 30 m/s, what velocity is required in the water tunnel?

For dynamic similarity, the Reynolds number must be the same for model and prototype. Thus,

$$\frac{V_m D_m}{\nu_m} = \frac{V D}{\nu}$$

so that

$$V_m = \frac{\nu_m}{\nu} \frac{D}{D_m} V$$

Since, ν_m (water @ 20°C) $= 1.004 \times 10^{-6}$ m²/s (Table B.2), ν (seawater @ 15.6°C) $= 1.17 \times 10^{-6}$ m²/s (Table 1.6), and $D/D_m = 5$, it follows that

$$V_m = \frac{\left(1.004 \times 10^{-6} \frac{m^2}{s}\right)}{\left(1.17 \times 10^{-6} \frac{m^2}{s}\right)} (5)(30 \frac{m}{s}) = \underline{\underline{129 \frac{m}{s}}}$$