8.74

8.74 Air flows through a rectangular galvanized iron duct of size 0.30 m by 0.15 m at a rate of 0.068 m³/s. Determine the head loss in 12 m of this duct.

$$h_L = f \frac{\ell}{D_h} \frac{V^2}{2g}, \quad \text{where} \quad D_h = \frac{4A}{P} = \frac{4(0.3m)(0.15m)}{2[0.3m + 0.15m]} = 0.2 \, m$$

and

$$V = \frac{Q}{A} = \frac{0.068 \frac{m^3}{s}}{(0.3m)(0.15m)} = 1.51 \frac{m}{s} \quad \text{Also,} \quad Re_h = \frac{VD_h}{\nu} = \frac{(1.51\frac{m}{s})(0.2m)}{1.46 \times 10^{-5} \frac{m^2}{s}} = 20,700$$

and from Table 8.1,

$$\frac{\varepsilon}{D_h} = \frac{0.15 \times 10^{-3} m}{0.2 \, m} = 7.5 \times 10^{-4} \quad \text{Hence, from Fig. 8.20} \quad f = 0.027$$

so that

$$h_L = (0.027)\left(\frac{12m}{0.2m}\right) \frac{(1.51\frac{m}{s})^2}{2(9.81\frac{m}{s^2})} = \underline{0.188m}$$