

9.13

**9.13** Water flows past a flat plate that is oriented parallel to the flow with an upstream velocity of 0.5 m/s. Determine the approximate location downstream from the leading edge where the boundary layer becomes turbulent. What is the boundary layer thickness at this location?

$$Re_{cr} = 5 \times 10^5 = \frac{U x_{cr}}{\nu}$$

$$x_{cr} = \frac{5 \times 10^5 \nu}{U} = \frac{5 \times 10^5 (1.12 \times 10^{-6} \text{ m}^2/\text{s})}{0.5 \text{ m/s}} = \underline{\underline{1.12 \text{ m}}}$$

$$\delta = 5 \sqrt{\frac{\nu x}{U}} = 5 \sqrt{\frac{(1.12 \times 10^{-6} \text{ m}^2/\text{s}) (1.12 \text{ m})}{0.5 \text{ m/s}}} = \underline{\underline{7.92 \times 10^{-3} \text{ m}}}$$