

9.10

9.10 A viscous fluid flows past a flat plate such that the boundary layer thickness at a distance 1.3 m from the leading edge is 12 mm. Determine the boundary layer thickness at distances of 0.20, 2.0, and 20 m from the leading edge. Assume laminar flow.

For laminar flow  $\delta = C\sqrt{X}$ , where  $C$  is a constant.

Thus,

$$C = \frac{\delta}{\sqrt{X}} = \frac{12 \times 10^{-3} \text{ m}}{\sqrt{1.3 \text{ m}}} = 0.0105 \quad \text{or} \quad \delta = 0.0105 \sqrt{X} \quad \text{where } X \sim \text{m}, \delta \sim \text{m}$$

$X, \text{ m}$	$\delta, \text{ m}$	$\delta, \text{ mm}$
0.2	0.00470	4.70
2.0	0.0148	14.8
20.0	0.0470	47.0

9.11

9.11 If the upstream velocity of the flow in Problem 9.10 is  $U = 1.5 \text{ m/s}$ , determine the kinematic viscosity of the fluid.

$$\text{For laminar flow } \delta = 5\sqrt{\frac{\nu X}{U}}, \text{ or } \nu = \frac{U\delta^2}{25X}$$

Thus,

$$\nu = \frac{(1.5 \frac{\text{m}}{\text{s}})(12 \times 10^{-3} \text{ m})^2}{25(1.3 \text{ m})} = \underline{\underline{6.65 \times 10^{-6} \frac{\text{m}^2}{\text{s}}}}$$