Q 8.8

a) $Re_x = \frac{V_\infty x}{\nu} = \frac{20 \times 1}{1.004 \times 10^{-6}} = 1.9 \times 10^7$

b) friction velocity $u^* = \sqrt{\frac{\tau_0}{\rho}} = V_\infty \sqrt{\frac{C_f}{2}}$

$$C_f = \frac{0.455}{\ln^2(0.06 Re_x)} = \frac{0.455}{\ln^2(0.06 \times 1.9 \times 10^7)} = 2.3 \times 10^{-3}$$

$$u^* = 20 \sqrt{\frac{2.3 \times 10^{-3}}{2}} = 0.67 \text{ m/s}$$

c) $0 \leq y^+ \leq 7 \rightarrow y^+ = \frac{y u^*}{\nu} \rightarrow y = \frac{\nu y^+}{u^*} = \frac{1.004 \times 10^{-6} \times 7}{0.67}$

$y = 1.049 \times 10^{-5}$ m

d) $50 \leq y^+ \leq 1500$

$y^+ = 50 \rightarrow \frac{y u^*}{\nu} = 50 \rightarrow y = \frac{\nu y^+}{u^*} = \frac{1.004 \times 10^{-6} \times 50}{0.67}$

$y = 7.49 \times 10^{-5}$ m

$y^+ = 1500 \rightarrow \frac{y u^*}{\nu} = 1500 \rightarrow y = \frac{\nu y^+}{u^*} = \frac{1.004 \times 10^{-6} \times 1500}{0.67}$

$y = 2.247 \times 10^{-3}$ m