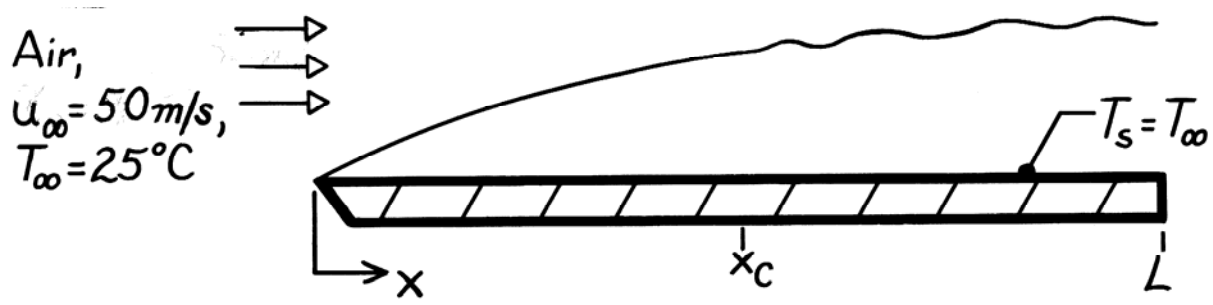
## PROBLEM 6.19

**KNOWN:** Air speed and temperature in a wind tunnel.

**FIND:** (a) Minimum plate length to achieve a Reynolds number of $10^8$, (b) Distance from leading edge at which transition would occur.

**SCHEMATIC:**




**ASSUMPTIONS:** (1) Isothermal conditions, $T_s = T_\infty$.

**PROPERTIES:** *Table A-4*, Air (25°C = 298K): $\nu = 15.71 \times 10^{-6}$ m$^2$/s.

**ANALYSIS:** (a) The Reynolds number is

$$Re_x = \frac{\rho\, u_\infty x}{\mu} = \frac{u_\infty x}{\nu}.$$

To achieve a Reynolds number of $1 \times 10^8$, the minimum plate length is then

$$L_{min} = \frac{Re_x\, \nu}{u_\infty} = \frac{1\times10^8 \left(15.71\times10^{-6}\,\text{m}^2/\text{s}\right)}{50\ \text{m/s}}$$

$$L_{min} = 31.4\ \text{m}. \quad <$$

(b) For a transition Reynolds number of $5 \times 10^5$

$$x_c = \frac{Re_{x,c}\, \nu}{u_\infty} = \frac{5\times10^5 \left(15.71\times10^{-6}\,\text{m}^2/\text{s}\right)}{50\ \text{m/s}}$$

$$x_c = 0.157\ \text{m}. \quad <$$

**COMMENTS:** Note that

$$\frac{x_c}{L} = \frac{Re_{x,c}}{Re_L}$$

This expression may be used to quickly establish the location of transition from knowledge of $Re_{x,c}$ and $Re_L$.