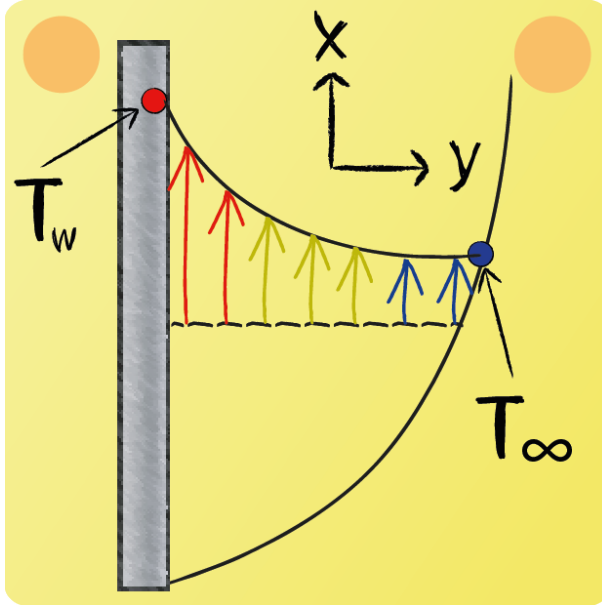


Lecture 3 - Question 4



Consider free convection, where $\beta = 3.50 \cdot 10^{-3} K^{-1}$, $g = 9.81 m/s^2$, $T_w = 20^\circ C$, $T_\infty = 0^\circ C$, $L = 0.1 m$, $\nu = 1.5 \cdot 10^{-5} m^2/s$, $\rho = 1.2 kg/m^3$ and $Pr = 0.73$. Can the flow be considered laminar and isothermal? Assume steady-state heat transfer and the fluid to be ideal.

$$Gr_L = \frac{\rho^2 g \beta (T_w - T_\infty) L^3}{\eta^2}$$

$$Gr_L = \frac{1.2^2 \cdot 9.81 \cdot 3.50 \cdot 10^{-3} \cdot (20 - 0) \cdot 0.1^3}{(1.5 \cdot 10^{-5})^2} = 4.34 \cdot 10^6$$

$$Gr_L \cdot Pr = 0.73 \cdot 4.34 \cdot 10^6 = 3.208 \cdot 10^6 < 4 \cdot 10^9$$

Yes. For natural convection, a flow can be considered to be laminar and isothermal when $Gr \cdot Pr \leq 4 \cdot 10^9$