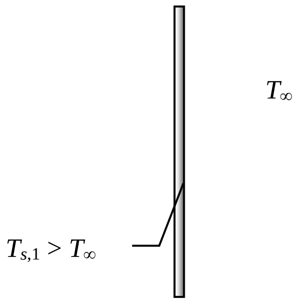
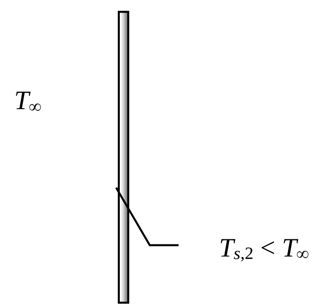
ACTIVE LEARNING EXERCISE—Natural convection in enclosures

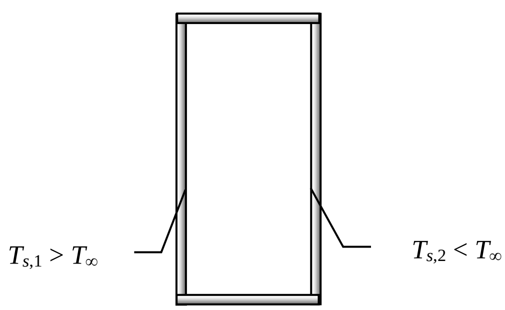
1. Imagine a vertical plate at a temperature $T_{s,1}$ in a quiescent fluid at T_∞. Assuming that $T_{s,1} > T_\infty$, sketch the velocity boundary layer that forms as a result of the temperature-induced density gradients next to the wall.



2. Now imagine a vertical plate at a temperature $T_{s,1}$ in a quiescent fluid at T_∞, but this time assume that $T_{s,1} < T_\infty$, sketch the velocity boundary layer that forms as a result of the temperature-induced density gradients next to the wall.

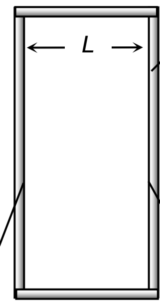


3. Let us bring the two vertical plates close to each other, and then cap the top and bottom to form an ___________________. Sketch what you think the flow pattern of fluid would look like in the enclosure.



4. We know the fluid is not stationary, but if it were, what would be the mode of heat transfer between the walls?

5. For steady state, write an expression for the rate of heat transfer between the two walls *assuming no fluid motion*.



6. Since there really is fluid motion, we know the mode of heat transfer is ______________. Does it make since to use ($T_{s,1}$ - T_∞) as the temperature difference for the total heat transfer rate across the entire enclosure? What about ($T_{s,2}$ - T_∞)? What temperature difference *does* make sense to use? What would your expression for the rate of heat transfer look like, then?

7. We can still calculate the rate of heat transfer assuming we have steady-state, 1-D conduction as in part 5., *if* we use a pretend, **effective conductivity** of the fluid.

   This pretend conductivity is larger/smaller than the actual conductivity due to the fluid motion. (circle one)

   And so finally, equate your expressions for heat transfer rate in parts 5. and 6., but write the equation and solve it for the effective thermal conductivity of the fluid. (Hint, remember that $Nu = hL_{chr}/k$ where k is the real thermal conductivity of the fluid.