Problem 1

Consider a vertical wall of height H in contact with an isothermal fluid reservoir. For the purpose of scale analysis, select the square flow region of height H and horizontal thickness H. Show that if in the momentum equation you invoke a balance between friction and buoyancy, the inertia/friction ratio comes out to be of order $Gr_H = (g\beta\ \Delta T\ H^3)/\nu^2$ (note that the H × H region is not the boundary layer region; hence, the conclusion "inertia/friction ~ Gr_H" does not apply to the boundary layer region). Is the vertical velocity scale derived above compatible with the *v* scale recommended by the energy equation for the H × H region? In other words, is the invoked balance friction ~ buoyancy in the H × H region realistic?

Problem 2

Using natural flows, a solar chimney has to be designed to heat the air to a uniform temperature at a constant mass flow rate. The chimney is planned to design using two parallel walls with the width of the wall significantly higher than the height of the chimney. Design the chimney by looking into the H/D. what is the condition for which the designed chimney will work and will be able to discharge fluid at a constant rate? Assume any necessary conditions with proper justification.

Hint: Find the average heat flux between the two parallel walls facing each other as depicted in the figure.

Assume the necessary conditions for an analytical solution to the problem. Validate your assumptions with the necessary condition