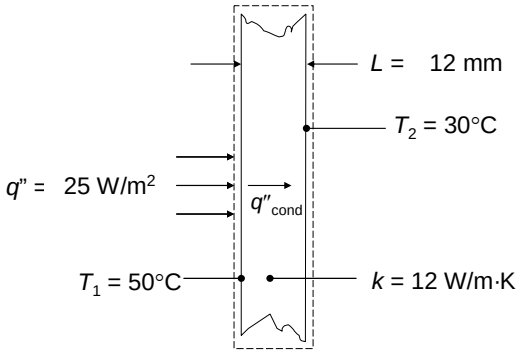
PROBLEM 1.2

KNOWN: Thickness and thermal conductivity of a wall. Heat flux applied to one face and temperatures of both surfaces.

FIND: Whether steady-state conditions exist.

SCHEMATIC:



ASSUMPTIONS: (1) One-dimensional conduction, (2) Constant properties, (3) No internal energy generation.

ANALYSIS: Under steady-state conditions an energy balance on the control volume shown is

$$q''_{in} = q''_{out} = q''_{cond} = k(T_1 - T_2)/L = 12\ \text{W/m}\cdot\text{K}(50°\text{C} - 30°\text{C})/0.012\ \text{m} = 20{,}000\ \text{W/m}^2$$

Since the heat flux in at the left face is only 25 W/m^2, the conditions are not steady state. <

COMMENTS: If the same heat flux is maintained until steady-state conditions are reached, the steady-state temperature difference across the wall will be

$$\Delta T = q''L/k = 25\ \text{W/m}^2 \times 0.012\ \text{m}/12\ \text{W/m}\cdot\text{K} = 0.025\ \text{K}$$

which is much smaller than the specified temperature difference of 20°C.