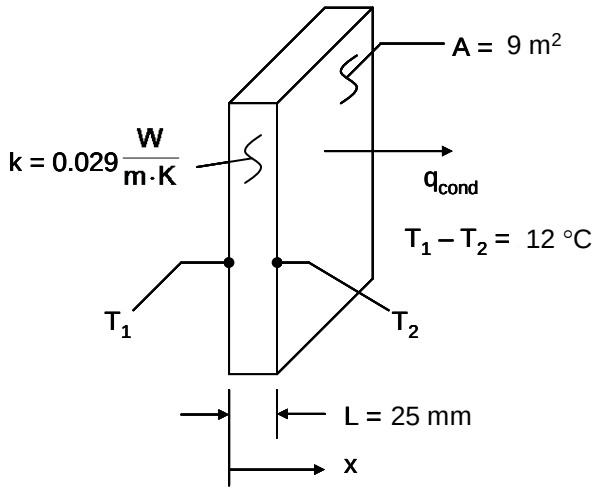
PROBLEM 1.2

KNOWN: Thermal conductivity, thickness and temperature difference across a sheet of rigid extruded insulation.

FIND: (a) The heat flux through a 3 m × 3 m sheet of the insulation, (b) the heat rate through the sheet, and (c) the thermal conduction resistance of the sheet.

SCHEMATIC:



ASSUMPTIONS: (1) One-dimensional conduction in the x-direction, (2) Steady-state conditions, (3) Constant properties.

ANALYSIS: (a) From Equation 1.2 the heat flux is

$$q''_x = -k\frac{dT}{dx} = k\frac{T_1 - T_2}{L} = 0.029\frac{W}{m\cdot K} \times \frac{12\ K}{0.025\ m} = 13.9\frac{W}{m^2} \quad <$$

(b) The heat rate is

$$q_x = q''_x \cdot A = 13.9\frac{W}{m^2} \times 9\ m^2 = 125\ W \quad <$$

(c) From Eq. 1.11, the thermal resistance is

$$R_{t,cond} = \Delta T / q_x = 12\ K / 125\ W = 0.096\ K/W \quad <$$

COMMENTS: (1) Be sure to keep in mind the important distinction between the heat flux (W/m^2) and the heat rate (W). (2) The direction of heat flow is from hot to cold. (3) Note that a temperature *difference* may be expressed in kelvins or degrees Celsius. (4) The conduction thermal resistance for a plane wall could equivalently be calculated from $R_{t,cond} = L/kA$.