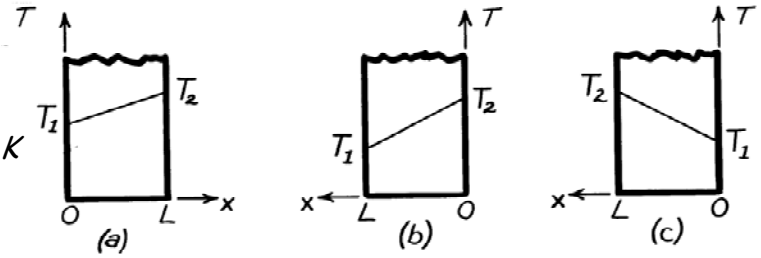
## PROBLEM 2.12

**KNOWN:** Plane wall with prescribed thermal conductivity, thickness, and surface temperatures.

**FIND:** Heat flux, $q''_x$, and temperature gradient, dT/dx, for the three different coordinate systems shown.

**SCHEMATIC:**

$T_1 = 500$ K
$T_2 = 700$ K
$k = 120$ W/m·K
$L = 120$ mm




**ASSUMPTIONS:** (1) One-dimensional heat flow, (2) Steady-state conditions, (3) No internal generation, (4) Constant properties.

**ANALYSIS:** The rate equation for conduction heat transfer is

$$q''_x = -k\frac{dT}{dx}, \tag{1}$$

where the temperature gradient is constant throughout the wall and of the form

$$\frac{dT}{dx} = \frac{T(L) - T(0)}{L}. \tag{2}$$

Substituting numerical values, find the temperature gradients,

(a) $$\frac{dT}{dx} = \frac{T_2 - T_1}{L} = \frac{(700 - 500)\,K}{0.120\,m} = 1667\ K/m$$ <

(b) $$\frac{dT}{dx} = \frac{T_1 - T_2}{L} = \frac{(500 - 700)\,K}{0.120\,m} = -1667\ K/m$$

<

(c) $$\frac{dT}{dx} = \frac{T_2 - T_1}{L} = \frac{(700 - 500)\,K}{0.120\,m} = 1667\ K/m.$$ <

The heat rates, using Eq. (1) with k = 120 W/m·K, are

(a) $$q''_x = -120\frac{W}{m\cdot K} \times 1667\ K/m = -200\ kW/m^2$$ <

(b) $$q''_x = -120\frac{W}{m\cdot K}(-1667\ K/m) = +200\ kW/m^2$$ <

(c) $$q''_x = -120\frac{W}{m\cdot K}(1667\ K/m) = -200\ kW/m^2$$ <