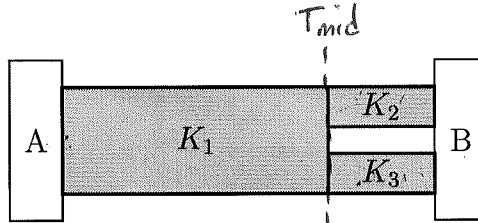


*. (8 points) System A is at 40°C and system B is at 0°C . The two systems are connected by a sequence of rods with conductances $K_1 = 100 \text{ W/K}$, $K_2 = 125 \text{ W/K}$ and $K_3 = 175 \text{ W/K}$, as shown below.



$$K_{23} = K_2 + K_3 = 300 \text{ W/K}$$

$$K_{123} = \left(\frac{1}{K_1} + \frac{1}{K_{23}} \right)^{-1} = 75 \text{ W/K}$$

Calculate the rate of heat flow through each rod and the temperature in the middle where K_1 is connected to the parallel combination of K_2 and K_3 .

$$\left(\frac{dQ}{dt} \right)_{\text{overall}} = \left(\frac{dQ}{dt} \right)_1 = \left(\frac{dQ}{dt} \right)_2 + \left(\frac{dQ}{dt} \right)_3 = K_{123} \Delta T_{\text{overall}} = (75 \text{ W/K}) (40^\circ\text{C}) = 3000 \text{ W}$$

$$\left(\frac{dQ}{dt} \right)_1 = K_1 (T_A - T_{\text{mid}}) \Rightarrow T_A - T_{\text{mid}} = \frac{3000 \text{ W}}{100 \text{ W/K}} = 30^\circ\text{C} \Rightarrow T_{\text{mid}} = 10^\circ\text{C}$$

$$\left(\frac{dQ}{dt} \right)_2 = K_2 (T_{\text{mid}} - T_B) = (125 \text{ W/K}) (10^\circ\text{C}) = 1250 \text{ W}$$

$$\left(\frac{dQ}{dt} \right)_3 = K_3 (T_{\text{mid}} - T_B) = 1750 \text{ W} \leftarrow \text{adds to } 3000 \text{ W} \checkmark$$