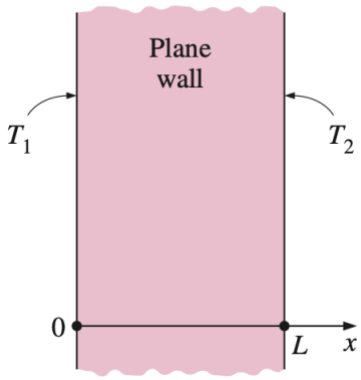
Topic 1 Heat Conduction in a Plane Wall

Consider a large plane wall of thickness L =0.2 m, thermal conductivity k=1.2 W/m · °C, and surface area A =15 m^2. The two sides of the wall are maintained at constant temperatures of T_1=120°C and T_2=50°C, respectively, as shown in below Figure. Determine (*a*) the variation of temperature within the wall and the value of temperature at x=0.1 m and (*b*) the rate of heat conduction through the wall under steady conditions.



SOLUTION A plane wall with specified surface temperatures is given. The variation of temperature and the rate of heat transfer are to be determined.

Assumptions **1** Heat conduction is steady. **2** Heat conduction is one-dimensional since the wall is large relative to its thickness and the thermal conditions on both sides are uniform. **3** Thermal conductivity is constant. **4** There is no heat generation.

Properties The thermal conductivity is given to be k =1.2 W/m · °C.

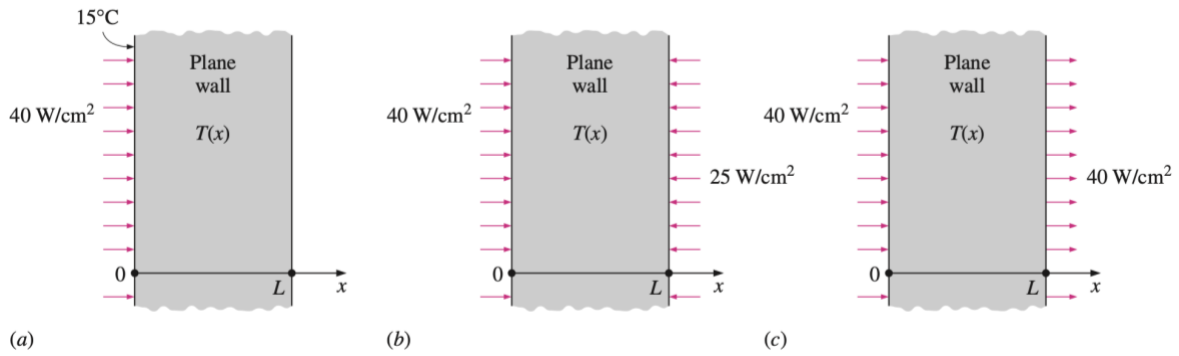
Topic 2 A Wall with Various Sets of Boundary Conditions

Consider steady one-dimensional heat conduction in a large plane wall of thickness L and constant thermal conductivity k with no heat generation. Obtain expressions for the variation of temperature within the wall for the following pairs of boundary conditions

$$(a)\ -k\frac{dT(0)}{dx}=\dot{q}_0=\frac{40W}{cm^2}\ and\ T(0)=T_0=15\ ℃$$

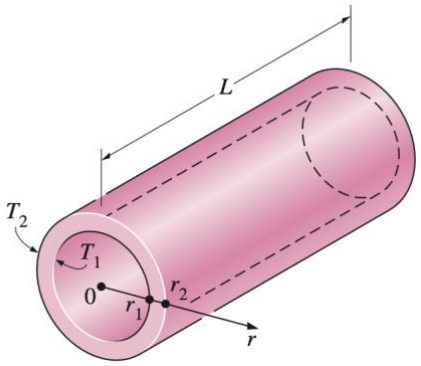
$$(b)\ -k\frac{dT(0)}{dx}=\dot{q}_0=\frac{40W}{cm^2}\ and\ -k\frac{dT(L)}{dx}=\dot{q}_L=-\frac{25W}{cm^2}$$

$$(c)\ -k\frac{dT(0)}{dx}=\dot{q}_0=\frac{40W}{cm^2}\ and\ -k\frac{dT(L)}{dx}=\dot{q}_L=\frac{40W}{cm^2}$$



Topic 3 Heat Loss through a Steam Pipe

Consider a steam pipe of length L=20 m, inner radius r_1=6 cm, outer radius r_3=8 cm, and thermal conductivity k=20 W/m·°C, as shown in below Figure. The inner and outer surfaces of the pipe are maintained at average temperatures of T_1=150°C and T_2=60°C, respectively. Obtain a general relation for the temperature distribution inside the pipe under steady conditions, and determine the rate of heat loss from the steam through the pipe.

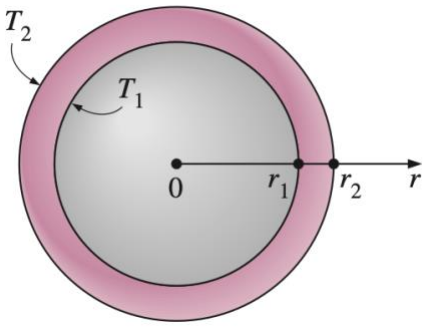


SOLUTION A steam pipe is subjected to specified temperatures on its surfaces. The variation of temperature and the rate of heat transfer are to be determined.
Assumptions **1** Heat transfer is steady since there is no change with time. **2** Heat transfer is one-dimensional since there is thermal symmetry about the centerline and no variation in the axial direction, and thus $T = T(r)$. **3** Thermal conductivity is constant. **4** There is no heat generation.

Properties The thermal conductivity is given to be k =20 W/m · °C.

Topic 4 Heat Conduction through a Spherical Shell

Consider a spherical container of inner radius r_1=8 cm, outer radius r_2=10 cm, and thermal conductivity k=45 W/m · °C, as shown in below Figure. The inner and outer surfaces of the container are maintained at constant tem- peratures of T_1=200°C and T_2=80°C, respectively, as a result of some chemical reactions occurring inside. Obtain a general relation for the temperature distribution inside the shell under steady conditions, and determine the rate of heat loss from the container.



SOLUTION A spherical container is subjected to specified temperatures on its surfaces. The variation of temperature and the rate of heat transfer are to be determined.
Assumptions **1** Heat transfer is steady since there is no change with time. **2** Heat transfer is one-dimensional since there is thermal symmetry about the midpoint, and thus $T = T(r)$. **3** Thermal conductivity is constant. **4** There is no heat generation.

Properties The thermal conductivity is given to be k=45 W/m · °C.