Chapter 16 Problem 58 †

Given
$l = 40\ cm = 0.40\ m$
$D = 3.0\ cm = 0.030\ m\ r = 0.015\ m$
$k_{iron} = 80.4\ W/m \cdot K$

Solution
Find the heat flow rate along the rod when one end is in ice water and the other in boiling water.

The conductive heat flow is calculated from the formula

$$H = -kA\frac{\Delta T}{\Delta x}$$

The cross sectional area of the rod is

$$A = \pi r^2 = \pi(0.015\ m)^2 = 7.07 \times 10^{-4}\ m^2$$

Substituting this into the heat flow formula along with the other provided values gives

$$H = -(80.4\ W/m \cdot K)(7.07 \times 10^{-4}\ m^2)\frac{100\ K}{0.40\ m} = -14.2\ W$$

The negative sign indicates that the heat flow is from the higher to the lower temperatures.

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†Problem from Essential University Physics, Wolfson