

Chapter 16 Problem 67 †

Given

$$D = 15 \text{ cm} = 0.15 \text{ m}$$

$$r = 0.075 \text{ m}$$

$$l = 65 \text{ cm} = 0.65 \text{ m}$$

$$P = 34 \text{ kW} = 34000 \text{ W}$$

Solution

What is the temperature of the log?

First find the surface area of the log. Each end of the log will have the area of a circle.

$$A_{end} = \pi r^2 = \pi(0.075 \text{ m})^2 = 0.0177 \text{ m}^2$$

The side of the cylinder has an area of

$$A_{side} = 2\pi r l = 2\pi(0.075 \text{ m})(0.65 \text{ m}) = 0.306 \text{ m}^2$$

The total surface area of the log is then

$$A = A_{side} + 2A_{end} = (0.306 \text{ m}^2) + 2(0.0177 \text{ m}^2) = 0.341 \text{ m}^2$$

From the Stefan-Boltzmann equation we have

$$P = \epsilon \sigma A T^4$$

Assuming emissivity is 1, then the temperature is

$$T = \left(\frac{P}{\sigma A} \right)^{1/4} = \left(\frac{34000 \text{ W}}{(5.67 \times 10^{-8} \text{ W/m}^2 \cdot \text{K}^4)(0.341 \text{ m}^2)} \right)^{1/4} = 1150 \text{ K}$$

†Problem from Essential University Physics, Wolfson