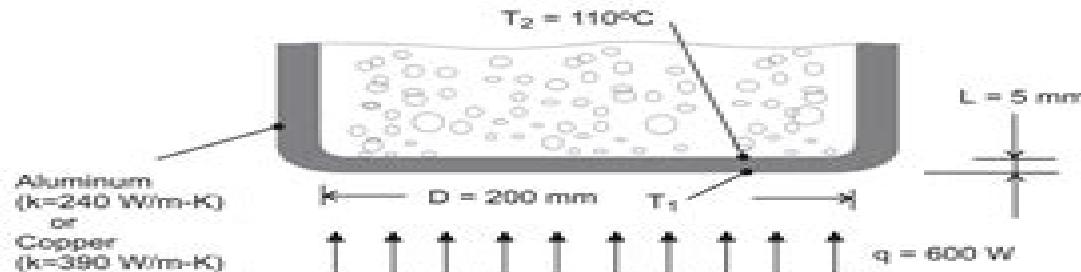


### PROBLEM 1.10

**KNOWN:** Thickness, diameter and inner surface temperature of bottom of pan used to boil water. Rate of heat transfer to the pan.

**FIND:** Outer surface temperature of pan for an aluminum and a copper bottom.

**SCHEMATIC:**



**ASSUMPTIONS:** (1) One-dimensional, steady-state conduction through bottom of pan.

**ANALYSIS:** From Fourier's law, the rate of heat transfer by conduction through the bottom of the pan is

$$q = kA \frac{T_1 - T_2}{L}$$

Hence,

$$T_1 = T_2 + \frac{qL}{kA}$$

where  $A = \pi D^2 / 4 = \pi (0.2 \text{ m})^2 / 4 = 0.0314 \text{ m}^2$ .

$$\text{Aluminum: } T_1 = 110^\circ\text{C} + \frac{600 \text{ W} (0.005 \text{ m})}{240 \text{ W/m}\cdot\text{K} (0.0314 \text{ m}^2)} = 110.40^\circ\text{C}$$

$$\text{Copper: } T_1 = 110^\circ\text{C} + \frac{600 \text{ W} (0.005 \text{ m})}{390 \text{ W/m}\cdot\text{K} (0.0314 \text{ m}^2)} = 110.25^\circ\text{C}$$

**COMMENTS:** Although the temperature drop across the bottom is slightly larger for aluminum (due to its smaller thermal conductivity), it is sufficiently small to be negligible for both materials. To a good approximation, the bottom may be considered *isothermal* at  $T = 110^\circ\text{C}$ , which is a desirable feature of pots and pans.

# Incropera Solution Manual

**Frank P. Incropera, Theodore L.  
Bergman, David P. DeWitt, Adrienne S.  
Lavine**

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