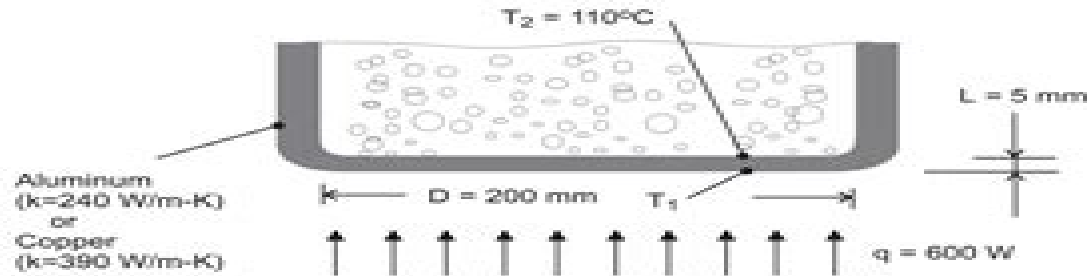


PROBLEM 1.10

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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Table of Contents Incropera Solution Manual

1. Understanding the eBook Incropera Solution Manual
 - The Rise of Digital Reading Incropera Solution Manual
 - Advantages of eBooks Over Traditional Books
2. Identifying Incropera Solution Manual
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Incropera Solution Manual
 - User-Friendly Interface
4. Exploring eBook Recommendations from Incropera Solution Manual
 - Personalized Recommendations

- Incropera Solution Manual User Reviews and Ratings
- Incropera Solution Manual and Bestseller Lists
- 5. Accessing Incropera Solution Manual Free and Paid eBooks
 - Incropera Solution Manual Public Domain eBooks
 - Incropera Solution Manual eBook Subscription Services
 - Incropera Solution Manual Budget-Friendly Options
- 6. Navigating Incropera Solution Manual eBook Formats
 - ePub, PDF, MOBI, and More
 - Incropera Solution Manual Compatibility with Devices
 - Incropera Solution Manual Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Incropera Solution Manual
 - Highlighting and Note-Taking Incropera Solution Manual
 - Interactive Elements Incropera Solution Manual
- 8. Staying Engaged with Incropera Solution Manual
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Incropera Solution Manual
- 9. Balancing eBooks and Physical Books Incropera Solution Manual
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Incropera Solution Manual
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Incropera Solution Manual
 - Setting Reading Goals Incropera Solution Manual
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Incropera Solution Manual
 - Fact-Checking eBook Content of Incropera Solution Manual

- Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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