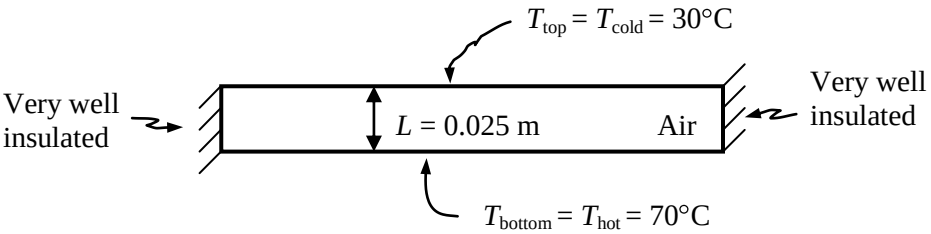
Problem Set # 9

Given: Wednesday, Nov. 14 **Recommended Completion Date:** Wednesday, Nov. 14
Do not submit for grading

Problem 1: A horizontal electrical cable of 25 mm diameter has a heat dissipation rate of 30 W/m. If the ambient air temperature is 27°C and can be assumed quiescent, estimate the surface temperature of the cable. (neglect radiation)

Ans.: 79.2°C

Problem 2: An air space over a horizontal solar collector is schematically illustrated in the figure below.



The lower plate of the horizontal air space is maintained at 70°C and the upper plate temperature is constant at 30°C. The side plates of this air space are very well insulated. Assume the length of the cavity is much larger than the air gap thickness L.

a) For an absolute air pressure of 1 atm, calculate the rate of heat transfer by natural convection across the air space.

b) For the same plate spacing and temperatures, determine the absolute pressure of the air in this space that would essentially eliminate natural convection.

Ans.: a) 135.2 W/m^2; b) $P_{air} \leq 0.203$ atm

Problem 3: Beer bottles are supposed to be cooled as fast as possible by arranging them in a refrigerator. As a first estimation and in the interest of maximizing the cooling rate, should the bottles be placed horizontally or vertically in the refrigerator compartment? Assume the radiation is negligible, and the free convection is the only heat transfer mode. Also, approximate the bottle geometry with a cylinder of 5 cm diameter and 20 cm long (L/D = 4).

Selected Problems from the Textbook

Please do the following problems:

6th Edition: **9.10** , **9.59** **or** 7th Edition : **9.16** , **9.58**