Problem 1.1

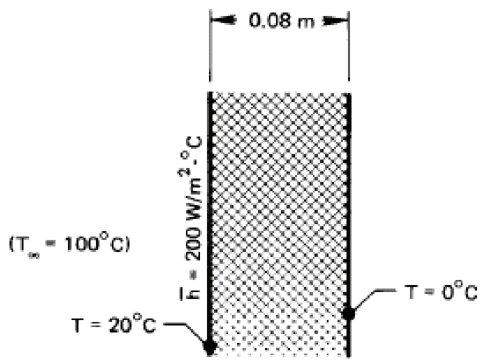
A composite wall consists of alternate layers of fir (5 cm thick), aluminum (1 cm thick), lead (1 cm thick), and corkboard (6cm thick). The temperature is 60˚C on the outside of the fir and 10˚C on the outside of the corkboard. Plot the temperature gradient through the wall. Does the temperature profile suggest any simplifying assumptions that might be made in the subsequent analysis of the wall?

1.8 A copper sphere 2.5 cm in diameter has a uniform temperature of 40˚C. The sphere is suspended in a slow-moving air stream at 0˚C. The air stream produces a convection heat transfer coefficient of 15 W/m^2K. Radiation can be neglected. Since copper is highly conductive, temperature gradients in the sphere will smooth out rapidly, and its temperature can be taken as uniform throughout the cooling process (i.e., Bi < 1). Write the instantaneous energy balance between the sphere and the surrounding air. Solve this equation and plot the resulting temperatures as a function of time between 40˚C and 0˚C.

1.18 As part of a space experiment, a small instrumentation package is released from a space vehicle. It can be approximated as a solid aluminum sphere, 4 cm in diameter. The sphere is initially at 30˚C and it contains a pressurized hydrogen component that will condense and malfunction at 30 K. If we take the surrounding space to be at 0 K, how long may we expect the implementation package to function properly? Is it legitimate to use the lumped-capacity method in solving the problem? (*Hint:* See the directions for Problem 1.17.) [Time = 5.8 weeks.]

1 .21 The thermal conductivity in a particular plane wall depends as follows on the wall temperature: $k = A + BT$, where A and B are constants. The temperatures are T_1 and T_2 on either side of the wall, and its thickness is L. Develop an expression for q.

1.22 Find k for the wall shown. Of what might it be made?



1.23 What are T_i, T_j, and T_r in the wall shown in the Figure? [T_j = 16.44˚C.]