Problem Set # 6

Given: Mon., Oct. 22 **Recommended Completion Date:** Mon., Oct. 29
Do not submit for grading

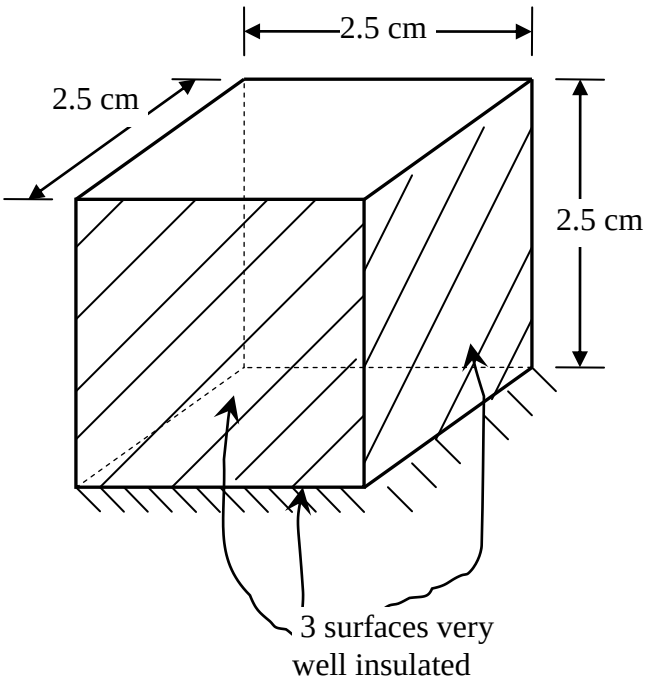
Problem 1: A plate of stainless steel (ρ = 7817 kg/m^3; c = 460 J/kg-°C; k = 19 W/m-°C) has thickness of 3 cm and is initially at a uniform temperature of T_i = 500°C. The plate is suddenly exposed to same convection cooling environment on sides characterized by T_∞= 40°C and h = 150 W/m^2-°C. Calculate the times for the center and face temperatures of the plate to reach 100°C.

Ans.: center: t = 787.76 s; face: t = 766.46 s *(Heisler Charts were used, please check these with one-term app.)*

Problem 2: A slab of metal (ρ = 8000 kg/m^3; c = 1000 J/kg-°C; k = 25 W/m-°C), in the shape of a rectangular parallelepiped and at a uniform temperature of T_i = 520°C, has three of its surfaces very well insulated (essentially adiabatic), as shown in the figure. At time t = 0 s it is suddenly exposed to convective cooling: T_∞= 20°C and h = 1000 W/m^2-°C.

a) At t = 200 s into the cooling process, what are the maximum and minimum temperature inside the slab?

b) If at this time, the cube is wrapped completely in excellent insulation (all surfaces essentially adiabatic) what would be its final equilibrium temperature?



Ans.: a) T_{max} = 96.08 ℃, T_{min} = 41.11 ℃; b) T_{final} = 72.05 ℃