Example

Dr. Thom bakes lots of brownies. In the process, he drips large amounts of brownie goo in his oven. He therefore is looking for a self-cleaning oven. One such oven design involves the use of a composite window separating the oven cavity from the room. The composite consists of two high temperature plastics (A and B) with thermal conductivities k_A = 0.15 W/(m·°C) and k_B = 0.08 W/(m·K) and thicknesses $L_A = 2L_B$. During the self-cleaning process, the oven air temperature is T_a = 400°C, while the room air temperature is T_∞ = 25°C. Convective heat transfer coefficients in and out of the oven are approximately 25 W/(m^2·°C).

(a) Find the minimum window thickness $L = L_A + L_B$ needed to ensure a temperature of 50°C on the outer window surface. (Hint: Use the resistance analogy and draw a thermal circuit. Assume that the cross sectional area of the window in 1 m^2 to make life easier.)

(b) Repeat part (a) if there is also a *radiation heat transfer coefficient* inside the oven of h_r = 25 W/(m^2·°C).