QUESTION1 write a summary (in your own words !, (in your own words !!!) about the convective heat transfer (half a page) and explain why increasing the thickness of a single pane glass does not increase the total resistane

Summary:

- Like conduction and radiation, convection (convective heat transfer) is one of the three ways of heat transfer.

- Convective heat transfer only occurs between fluid (gas and liquid), when each fluid with different temperature generates relative motion, transferring the heat from one part to the other part. (space and medium are needed)

- Simple procession of convective heat transfer does not exist, it always emerges with the procession of heat conduction.

- There are two main causes of convection: one is natural convection, which occurs when the fluid with same temperature gets heated or chilled, creating a temperature difference, leading to the relative motion; the other one is forced convection, which occurs when the fluid is under the external force (wind blowing, pumping process) and then generate convection.

- The level of natural convection is mainly up to the temperature difference among the fluid (the more difference there is, the stronger the convection conducts); likewise, the level of forced convection is mainly up to the degree of the external force (the stronger the external force is, the stronger the convection conducts)

explain why increasing the thickness of a single pane glass does not increase the total resistance

Unlike the situation of heat transfering in the solid material layer, where heat conduction takes the charge of heat transferring process thus the thicker the wall is, the higher the resistane is; however, in the air space, heat transfers with convection, radiation and conduction, and under this situation, the total resistance mainly depends on the thickness of the air boundary layer at the two interfaces and the radiation heat transfer intensity between interfaces.

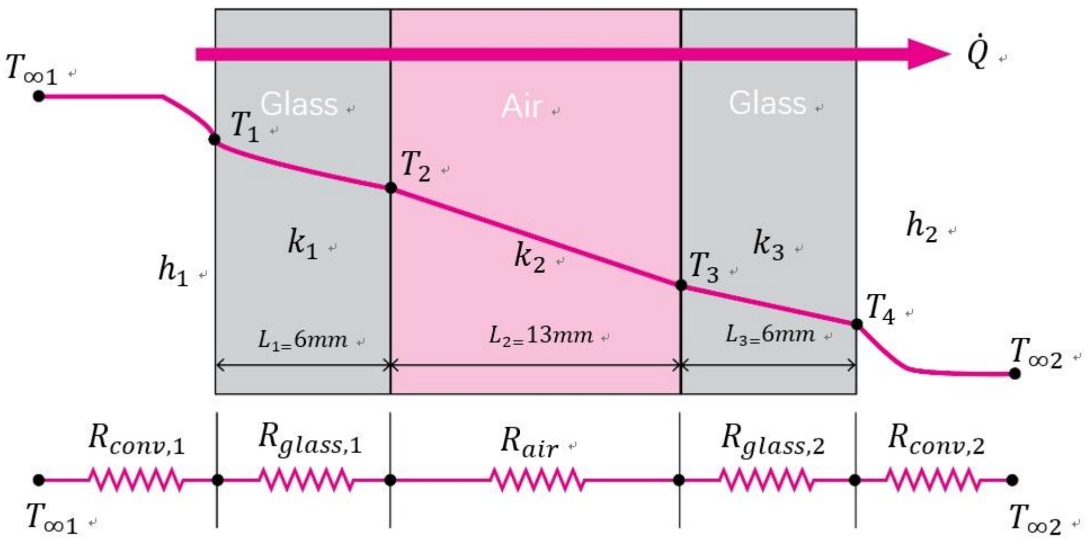
QUESTION2 write an explanation about what mistakes you made in the class that resulted in wrong answers !!

Without clear understanding, I ignored the thickness of the solid wall when calculating the thermal resistance of the wall.

QUESTION3 solve the same probelm as that of double pane window with with the air-gap thickness of 13 mm and glass thickness of 6 mm, commment on your results and explain why we have an optimal range for the air-gap's distance !

Consider a 0.8-m-high and 1.5-m-wide double-pane window consisting of two 6-mm-thick layers of glass (k= 0.78 W/m.°C) separated by a 13-mm-wide stagnant air space (k= 0.026 W/m.°C). Determine the steady rate of heat transfer through this double pane window and the temperature of its inner surface.

Take the convection heat transfer coefficients on the inner and outer surfaces of the window to be h1= 10 W/m2 · °C and h2=40 W/m2 · °C, which includes the effects of radiation.



$$R_{conv,1}=\frac{1}{h_1A} \quad R_{glass,1}=\frac{L_1}{k_1A} \quad R_{air}=\frac{L_2}{k_2A} \quad R_{glass,2}=\frac{L_3}{k_3A} \quad R_{conv,2}=\frac{1}{h_2A}$$

$A=0.8m\cdot1.5m=1.2m^2$

$$R_{conv,1}=\frac{1}{h_1A}=\frac{1}{\frac{10W}{m^2\cdot℃}\cdot1.2m^2}\approx0.0833℃/W$$

$$R_{glass,1}=\frac{L_1}{k_1A}=\frac{0.006m}{\frac{0.78W}{m\cdot℃}\cdot1.2m^2}\approx0.0064℃/W$$

$$R_{air}=\frac{L_2}{k_2A}=\frac{0.013m}{\frac{0.026W}{m\cdot℃}\cdot1.2m^2}\approx0.4167℃/W$$

$$R_{glass,2}=\frac{L_3}{k_3A}=\frac{0.006m}{\frac{0.78W}{m\cdot℃}\cdot1.2m^2}\approx0.0064℃/W$$

$$R_{conv,2} = \frac{1}{h_2 A} = \frac{1}{\frac{40W}{m^2 \cdot ℃} \cdot 1.2m^2} \approx 0.0208℃/W$$

$$R_{total} = R_{conv,1} + R_{glass,1} + R_{air} + R_{glass,2} + R_{conv,2} \approx 0.5333℃/W$$

$$\dot{Q} = \frac{T_{\infty 1} - T_{\infty 2}}{R_{total}} = \frac{20℃ - (-10℃)}{0.5333℃/W} \approx 56.2535W$$

$$\because \dot{Q} = \frac{T_{\infty 1} - T_1}{R_{conv,1}} = \frac{T_{\infty 1} - T_1}{1/h_1 A}$$

$$\therefore T_1 = T_{\infty 1} - \dot{Q} R_{conv,1} \approx 20℃ - 56.2535W \cdot 0.0833 \frac{℃}{W} \approx 15.3℃$$