1 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

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

3 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 !

1. Summary :

- Convective heat transfer refers to the transfer of heat from a fluid (liquid, gas) to a solid surface. This phenomenon occurs in the form of direct contact (fluid and solid) and macroscopic motion ; there must be a temperature difference.

- Several types of heat transfer:

(1) According to whether fluid has a flow phase change during convective heat transfer

- Single phase fluid convection heat transfer: the fluid has no phase change in the heat transfer , which is always liquid or gas phase.
- Changing phase fluid convection heat transfer: the fluid undergoes a phase change during convection heat transfer, such as the liquid phase becomes a boiling heat transfer in the gas phase, and the condensation heat transfer in the gas phase becomes a liquid phase.

(2) According to causes of fluid flow

- Natural convection : when fluid motion is caused by the density variations due to variation of thermal temperature in the fluid. When the fluid is contact with a hot surface , its molecules separate and scatter, causing the fluid to be less dense. As a result, the fluid is displaced while the cooler fluid gets denser and the fluid sinks. Thus , the hotter volume transfers heat towards the cooler volume of the fluid.
- Forced convection : when a fluid is forced to flow over the surface by an internal source such as fans, creating an artificially induced convection current.

- The rate of convective heat transfer depends on :
  - Temperature difference
  - Velocity of liquid or gas
  - Kind of liquid or gas

Explanation:

According to formula $R_{total} = R_{conv_1} + R_{conv_2} + R_g = \frac{1}{h_1 \times A} + \frac{1}{h_2 \times A} + \frac{L}{(K \times A)}$,

Because the thermal conductivity of the glass is a small data 0.78 W/m·°C, which can only have a small impact. Also, the thickness of the glass itself is small, and the thickness of the glass which can be increased is limited, thus, the thermal resistance of the window cannot be significantly increased.

2. **Explanation:**

Maybe because of a wrong decimal point, or a unit conversion error.

3. $\boldsymbol{A = \ 0.8 * 1.5 = 1.2}$

$$R_{g_1} = R_{g_2} = \frac{L_g}{(K_g \times A)} = \frac{0.006}{0.78 * 1.2} = 0.0064° \frac{C}{W}$$

$$R_{airGap} = \frac{L_{airGap}}{(K_{airGap} \times A)} = \frac{0.013}{0.026 * 1.2} = 0.4167 \ °C/W$$

$$R_{conv_1} = \frac{1}{\mathrm{h}_1 \times A} = (\frac{1}{10 * 1.2)} = 0.0833\, °C/W$$

$$R_{conv_2} = \frac{1}{\mathrm{h}_2 \times A} = (\frac{1}{40 * 1.2)} = 0.0208\, ° \frac{C}{W}$$

$$R_{tot} = R_{conv_1} + R_{conv_2} + 2 \times R_g + R_{airGap}$$

$$= 0.0833 + 0.0208 + 2 * 0.0064 + 0.4167 = 0.5336\, ° \frac{C}{W}$$

$$\dot{Q} = \frac{\Delta T}{R_{Tot}} = \frac{30}{0.5336} = 56.22\, W$$

$$\dot{Q} = \frac{T_{inff_1} - T_{s_1}}{R_{conv_1}} = \rightarrow 56.2 = \frac{20 - T_{s_1}}{0.0833} \rightarrow T_{S_1 = 15.3\, °C}$$

Explanation:

Referring to the formula $R_{airGap} = \frac{L_{airGap}}{(K_{airGap} \times A)}$, $\dot{Q} = \frac{\Delta T}{R_{Tot}}$, $\dot{Q} = \frac{T_{inff_1} - T_{s_1}}{R_{conv_1}}$,

once the air gap increase, its thermal resistance will be increase, then it has better heat preservation. But once the air gap exceeds a certain data(the optional point), due to the combined effect of convection and radiant heat exchange, the thermal resistance of the air layer is increased very slowly. That is ,when the convection heat transfer coefficient is very large , the convection resistance becomes zero, which means that the surface offers no resistance to convection ,and thus it does not slow down the heat transfer process.