QUESTION1

1 Write a summary about the tive heat transfer and explain why increasing the thickness of a single pane glass does not increase the total resistane.

Summary：

－Convective heat transfer, also known as convective motion, is one of three heat transfer modes. It occurs between two moving fluids (liquids and liquids, liquids and gases, gases and gases).

－Convective heat transfer occurs only between liquids. First, it occurs in fluids at different temperatures and in different parts. The fluids move relative to each other to transfer thermal energy.

－The reasons for the convection of the fluid are as follows:

－First, "natural convection." Fluids of the same temperature, because of the heat or cooling of a part of them, create a temperature difference, and finally form a convective motion. The extent of it depends on the temperature difference between different parts of the fluid. The greater the temperature difference, the stronger the convective motion.

－Second, because the fluid is subjected to external forces and then forced to convective motion, such as wind and pump pressure. This is "forced convection." The “forced movement” depends on the size of the external force. The greater the external force, the stronger the convective motion, and vice versa.

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

－The heat transfer process between the air is different from the solid material layer. The solid material layer transfers heat through heat conduction. However, in the air layer, three heat transfer modes of heat conduction, convection and radiation are apparent. Its heat transfer process is actually a heat transfer process between two surfaces within a limited air layer, including convective heat transfer and radiation transfer heat.

QUESTION2

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

－The thickness of the solid wall is ignored when calculating the thermal resistance of the wall. Simply applying the formula without a better understanding of the heat transfer principle and Factors that affect the thermal resistance of solid objects.

QUESTION3

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 !*

Determine the steady rate of heat transfer through this double-pane window and the temperature of its inner surface.

$$A = 0.8m \cdot 1.5m = 1.2m^2$$

$$R_{conv,1} = \frac{1}{h_1 A} = \frac{1}{\frac{10W}{m^2 \cdot ℃} \cdot 1.2m^2} \approx 0.0833℃/W$$

$$R_{glass,1} = \frac{L_1}{k_1 A} = \frac{0.006m}{\frac{0.78W}{m \cdot ℃} \cdot 1.2m^2} \approx 0.0064℃/W$$

$$R_{air} = \frac{L_2}{k_2 A} = \frac{0.013m}{\frac{0.026W}{m \cdot ℃} \cdot 1.2m^2} \approx 0.4167℃/W$$

$$R_{glass,2} = \frac{L_3}{k_3 A} = \frac{0.006m}{\frac{0.78W}{m \cdot ℃} \cdot 1.2m^2} \approx 0.0064℃/W$$

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

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

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

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

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