Answer on Question #51620, Physics, Other

A house has a door made of two layers of glass separated by an air layer. Each of the 3 layers has a thickness of 2.5mm and an area of 3.0m^2.The temperature outside the house is -10 ^{o}C, while the temperature inside the house +25^{o}C. What is the rate of heat transfer by conduction through the door? Assume steady state and k(glass)=1 Wm(-1)K(-1),k(air)=0.026 Wm(-1)K(-1)

Solution:

The heat conduction through a plane wall is

$$\dot{Q}_{cond} = \frac{T_1 - T_2}{R_{door}}$$

where

$$R_{wall} = \frac{L}{kA}$$

is the thermal resistance of the wall against heat conduction or simply the conduction resistance of the wall.

The area of the window and the individual resistances are

$$A = 3.0 \text{ m}^2$$

$$R_1 = R_3 = R_{glass} = \frac{L}{k_{glass}A} = \frac{2.5 * 10^{-3}}{1 * 3} = 0.00083 \text{ K/W}$$

$$R_2 = R_{air} = \frac{L}{k_{air}A} = \frac{2.5 * 10^{-3}}{0.026 * 3} = 0.032 \text{ K/W}$$

$$R_{door} = 2R_1 + R_2 = 2 * 0.00083 + 0.032 = 0.03366 \text{ K/W}$$

The steady rate of heat transfer through window glass then becomes

$$\dot{Q}_{cond} = \frac{T_1 - T_2}{R_{door}} = \frac{28 - (-10)}{0.03366} = 1128.94 \approx 1130 \text{ W}$$

Answer: $\dot{Q}_{cond} = 1130$ W.