Q1. Glass windows of a room has total area of $10m^2$ & glass is 4mm thick. Calculate quantity of heat leaving room through glass when, inside surface of window is at 25°c and outside surface is at 10°c. Value of themal conductivity for glass is 0.84 W/mk.?

Ans: Given;

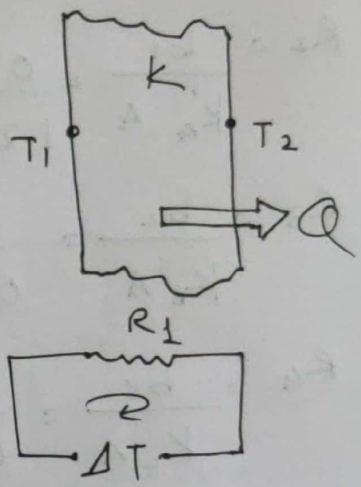
$A = 10 m^2$

$b = 4mm = 4 \times 10^{-3} m$

$T_1 = 25°C$

$T_2 = 10°C$

$k = 0.84 W/mk.$



$$R = \frac{b}{KA}$$

$$= \frac{4 \times 10^{-3}}{0.84 \times 10}$$

$$= 4.762 \times 10^{-4} K/W.$$

$$\therefore Q = \frac{\Delta T}{\Sigma R}$$

$$= \frac{(25-10)}{4.762 \times 10^{-4}}$$

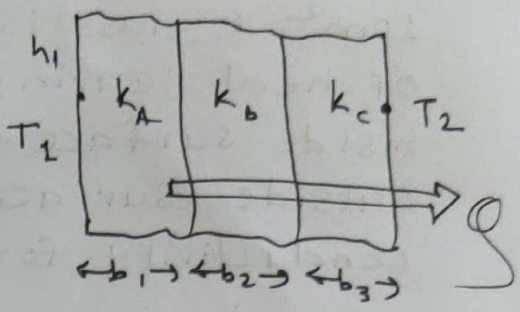
$$= 31.499 \times 10^3 W.$$

Q.2 Calculate rate of heat transfer per m^2 through wall of 200 mm thick inner layer of 'A', a central level of 'B' 100 mm thick and outer layer of 'C' ~~with hm = 74 W/m² °C and~~ 100 mm thick. Temp. of gas in furnance is 1670 °C with hm = 74 W/m² °C & outside surface temp of 'C' is 70° C

Given;- $k_A = 1.25\ W/m^\circ C$

$k_B = 0.074\ W/m^\circ C$

$k_C = 0.55\ W/m^\circ C$

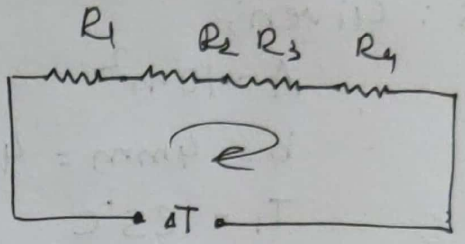


$$R_1 = \frac{1}{h_1 A} = \frac{1}{74A}\ k/w$$

$$R_2 = \frac{b_1}{k_A A} = \frac{0.2}{1.25A} = \frac{0.16}{A}$$

$$R_3 = \frac{b_2}{k_B A} = \frac{0.1}{0.074A} = \frac{1.351}{A}$$

$$R_4 = \frac{b_3}{k_C A} = \frac{0.1}{0.55A} = \frac{0.182}{A}$$



$$\Sigma R = R_1 + R_2 + R_3 + R_4$$

$$= \frac{1.706}{A}\ kw$$

$$Q = \frac{\Delta T}{\Sigma R}$$

$$= \frac{(T_1 - T_2)}{\Sigma R}$$

$$= \frac{(1670 - 70)}{\left(\frac{1.706}{A}\right)}$$

$$\frac{Q}{A} = 937.87\ W/m^2$$

3. A composite wall consist of 1.5 mm thick steel sheet & 10 mm plywood sheet seperated by 2mm thick glass wool in between. Calculate rate of heat flow per m^2 if temp. on steel sheet & plywood side is 25°C & -15°C resp. Also calculate interface temp.

k for steel = 23.23 W/mk

k for plywood = 0.052 W/mk

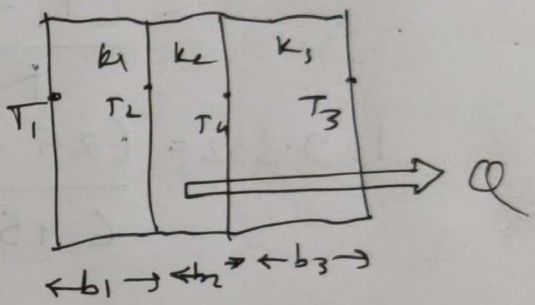
k for glasswool = 0.014 W/mk.

Ans: Given,

$b_1 = 105 \text{ mm} = 0.0015 \text{ m}$

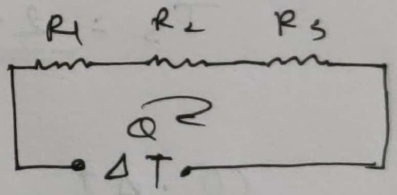
$b_2 = 2 \text{ mm} = 0.002 \text{ m}$

$b_3 = 10 \text{ mm} = 0.01 \text{ m}$



$$R_1 = \frac{b_1}{K_1 A} = \frac{0.0015}{23.23 \times 1}$$

$$= 6.457 \times 10^{-5} \text{ k/W}$$



$$R_2 = \frac{b_2}{K_2 A} = \frac{0.002}{0.014 \times 1}$$

$$= 0.1428 \text{ k/W}$$

$$R_3 = \frac{b_3}{K_3 A} = \frac{0.01}{0.052 \times 1}$$

$$= 0.1923 \text{ k/W}$$

$$\Sigma R = R_1 + R_2 + R_3$$

$$= 0.3352 \text{ k/W}$$

$$Q = \frac{\Delta T}{\Sigma R} = \frac{(T_1 - T_4)}{\Sigma R_t}$$

$$= \frac{(25 - (-15))}{0.3352}$$

$$= 119.332 \text{ W}.$$

Interface temp:-

$$Q = \frac{\Delta T}{\Sigma R}$$

$$= \frac{(T_1 - T_3)}{R_1}$$

$$119.332 = \frac{(25 - T_3)}{6.457 \times 10^{-5}}$$

$$T_3 = \underline{\underline{24.99^\circ C}}$$

$$Q = \frac{\Delta T}{\Sigma R} = \frac{(T_4 - T_2)}{R_3}$$

$$119.332 = \frac{[T_4 - (-15)]}{0.1923}$$

$$T_4 = 7.947^\circ C$$

Q.4. Calculate rate of heat transfer by convection between roof of area $20 \times 20 m^2$ & ambient air, if roof temp. is 10°C & air temp is 40°C. Assume ave. heat transfer coeff. of convection as $10 W/m^2 k$ Comment on heat flow.

Given :- Area = $20 \times 20 = 400\ m^2$

$T = 10^\circ C$

$T_\infty = 40^\circ C$

$h = 10\ W/m^2K$

$Q = hA(\Delta T)$

$= 10 \times 400 \times (40 - 40)$

$= -120 \times 10^3\ W.$

Q5. A 60 W incandescent lamp has coil surface temp. of 2500 k & room temp. of 300 k. Estimate surface area of coil.

Ans: Given;

$T_1 = 2500k$

$T_2 = 300k$

$Q = 60W$

A/c Stefan Boltzmann law;

$E = \sigma T^4 \quad \ldots\ldots E \propto T^4$

$\frac{Q}{A} = \sigma T^4$

$\frac{Q}{A} = \sigma (T_1^4 - T_2^4)$

$\frac{60}{A} = 5.67 \times 10^{-8} [(2500)^4 - (300)^4]$

$\therefore A = 2.7095 \times 10^{-5}\ m^2.$