natural convection:

when there is a warm obj in room, by movement of it molculs. warm air due to density moves

$T_s \xrightarrow{\dot{Q}} T_\infty$

up and cold air comes down. since warm air is lighter

inclusive → yesin

- Rate of convection heat transfer depends on

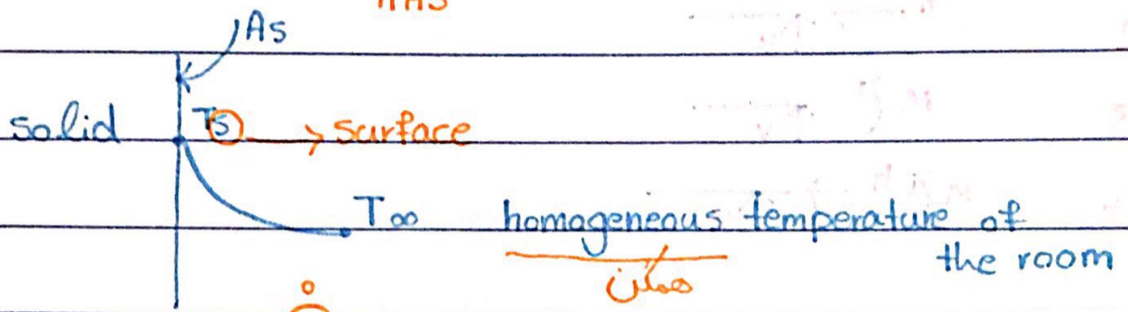
1. temperature difference
2. velocity of liquid or gas
3. kind of

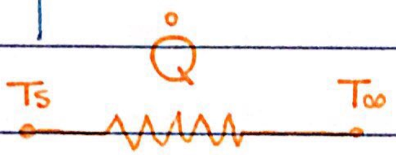
infinity لانهاية

1. $\dot{Q}_{conv} = hA_s(T_s - T_\infty)$

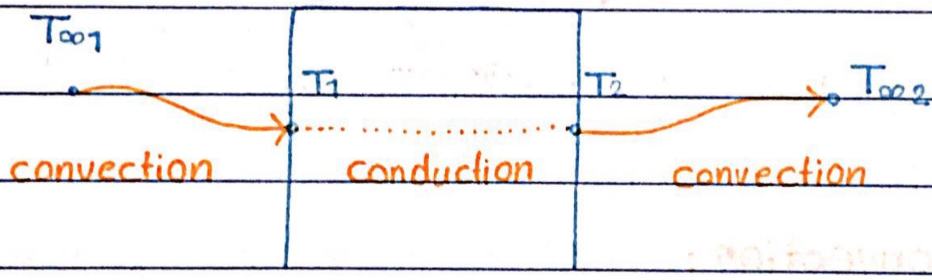
2. $\dot{Q}_{conv} = \dfrac{T_s - T_\infty}{R_{conv}}$ (W)

$$R_{conv} = \frac{1}{hA_s}$$





3. $R_{conv} = \dfrac{1}{hA_s}$ (°C/W)



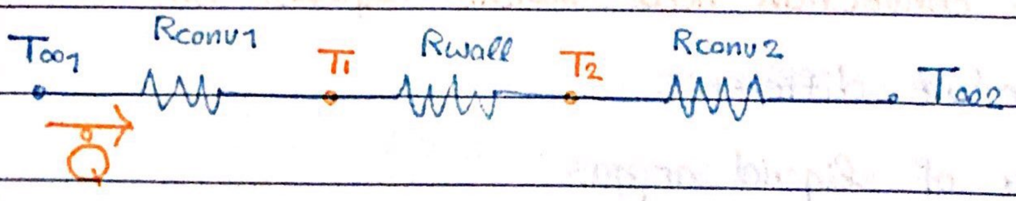
$R_{total} = R_{conv1} + R_{wall} + R_{conv2}$ ✓

$= \dfrac{1}{h_1 A} + \dfrac{\ell}{KA} + \dfrac{1}{h_2 A}$ (°C/W)

natural convection is happening inside (h_1)

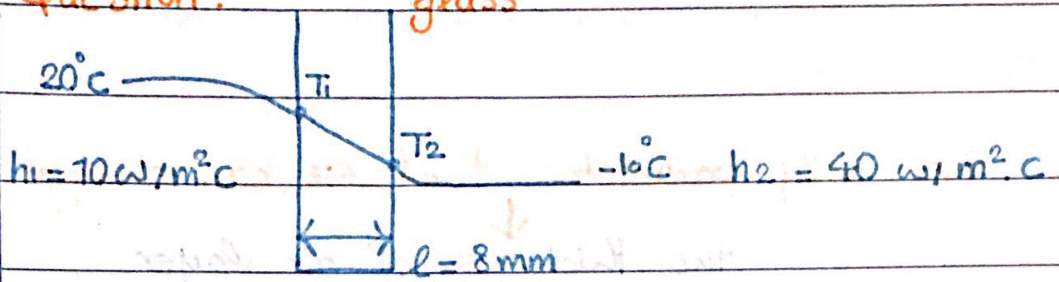
consider worst case, its forced convection outside (h_2)

$$\dot{Q} = \frac{T_{\infty 1} - T_{\infty 2}}{R_{total}}$$



thermal network

Question:



$l = ۰,۸m$ wide = 1.5 m K = 0.78 w/m.c

first calculate Rtotal

① $R_{total} \frac{1}{10 \times (1,5 \times ۰,۸)} + \frac{۰,۰۰۸}{۰,۷۸ \times ۱,۲} + \frac{1}{40 \times 1,2} = ۰,1126$

(1,5 × ۰,۸ = ۱,۲)

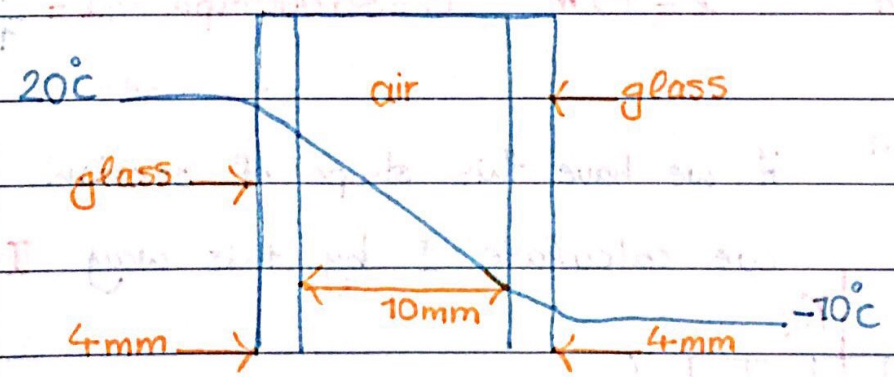
$Q = \frac{20-(-10)}{0,1126} = 266,4298 \; w$

a thick glass is usless it is just waste of money

How to measure T_1?

$\dot{Q} = \frac{T_{\infty 1} - T_1}{R_{conv_1}} \rightarrow 266,4 = \frac{20 - T_1}{0,0833} \rightarrow T_1 = -2,2°c$

در صورت مراحل
آسان است



heigh = ۰,۸ m wide = 1.5m K = 0.78 w/m°c

$R_{total} = \frac{1}{10 \times 1,2} + \left(\frac{0,004}{0.78 \times 1,2}\right)^{\times 2} + \frac{0,01}{0.026 \times 1,2} + \frac{1}{40 \times 1.2} = 0,433$

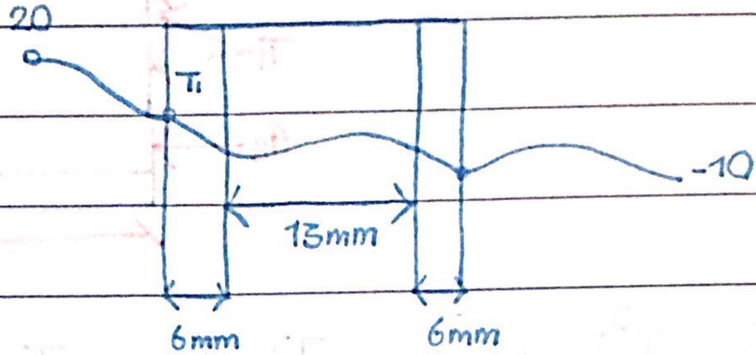
$K_{air} = 0.026$

NOTE: here we are considering that air does not move and we only have convection.

task NO 2.

$K_{air} = 0.026$

$K_2 = 0.078$



$R_{total} = R_{conv1} + R_{wall} + R_{conv2}$

$$\rightarrow \frac{1}{\underbrace{10}_{h_1} \times \underbrace{1,2}_{A}} + \left(\frac{0.006}{\underbrace{0.078}_{K} \times \underbrace{1,2}_{A}}\right) \times 2 + \frac{0,013}{0.026 \times 1,2} + \frac{1}{40 \times 1,2}$$

$$= 0,532$$

$$Q = \frac{\Delta T}{R_{total}} \rightarrow \frac{30}{0,532} = 56,39$$

$$56,39 = \frac{20 - T_1}{0,083} \rightarrow T_1 = 15,3 \, ^\circ C$$

Since conduction is better for transfering heat, the more conduction we have, the more heat would transfer by increasing the thickness of air, the way of transfering would be conduction otherwise it is convection. that's why we have an optimal range of thickness.