A 3 m high and 5 m wide wall consists of long 32 cm 22 cm cross section horizontal bricks (k = 0.72 W/m · °C) separated by 3 cm thick plaster layers (k =0.22 W/m · °C).
There are also 2 cm thick plaster layers on each side of the brick and a 3-cm-thick rigid foam (k 0.026 W/m · °C) on the inner side of the wall The indoor and the outdoor temperatures are 20°C and -10°C, and the convection heat transfer coefficients on the inner and the outer sides are h1=10 W/m2 · °C and h2 =40 W/m2 · °C, respectively.Assuming one-dimensional heat transfer and disregarding radiation, determine the rate of heat transfer through the wall.

$$R_i = \frac{1}{10 * 0.25} = 0.4\ C/w$$

$$R_f = \frac{0.03}{0.026 * 0.25} = 4.615\ C/w$$

$$R_{plaster\ upper} = R_{plaster\ down} = \frac{L_{p_{c_1}}}{k_p \times A_{p_{c_1}}} = \frac{0.32}{0.22 * 0.015} = 96.97\ °\frac{C}{W}$$

$$R_{brick} = \frac{L_b}{k_b \times A_b} = \frac{0.32}{0.72 * 0.22} = 2.02\ °\frac{C}{W}$$

$$\frac{1}{R_{tot_{parallel}}} = \frac{1}{R_{brick}} + \frac{1}{R_{p_{laster\ upper}}} + \frac{1}{R_{p_{laster\ down}}} = \frac{1}{2.02} + 2 * \left(\frac{1}{96.97}\right) = 0.516\ °\frac{C}{W}$$

$$\rightarrow \frac{1}{R_{tot_{parallel}}} = 0.516\ \frac{W}{°C R_{tot_{parallel}}} = \frac{1}{0.516} = 0.97°\frac{C}{W}$$

$$R_{P_1} = R_{P_2} = \frac{L_{p_1}}{k_p \times A_{p_1}} = \frac{0.02}{(0.22 * 0.25)} = 0.363\ °\frac{C}{W}$$

$$R_{P_2} = \frac{1}{\hbar_0 \times A} = \frac{1}{40 * 0.25} = 0.1\ °\frac{C}{W}$$

$$R_{total} = R_i + R_o + 2 * R_{P_1} + R_{tot_{parallel}} + R_{foam}$$

$$R_{total} = 7.781\ °C/W$$

$$\dot{Q} = \frac{\Delta T}{R_{Tot}} = \frac{30}{7.781} = 3{,}855\ W$$

Previous question with the same case with the difference of 16 cm bricks had the

$R_{total} = 6.81\,°\frac{C}{W}$

$\dot{Q} = \frac{\Delta T}{R_{Tot}} = \frac{30}{6.81} = 4{,}4052\ W$

Comparing these two results will give the outcome that: doubling the brick thickness will not be equal to doubling the thermal resistance.

- Determine the overall unit thermal resistance (the ***R***-value) and the overall heat transfer coefficient (the ***U***-factor) of a wood frame wall that is built around 38-mm 90-mm wood studs with a center-to-center distance of 400 mm. The 90-mm-wide cavity between the studs is filled with Urethane rigid foam insulation. The inside is finished with 13-mm gypsum wallboard and the outside with 13 mm plywood and 13-mm 200-mm wood bevel lapped siding. The insulated cavity constitutes 75 percent of the heat transmission area while the studs, plates, and sills constitute 21 percent. The headers constitute 4 percent of the area, and they can be treated as studs.

	Wood Section	Insulation Section
Outside Air	0.03	0.03
Wood Bevel (13mm*200mm)	0.14	0.14
Plywood (13mm)	0.11	0.11
Urethane Rigid Foam Insulation (90mm)	-	(90*0.98) / 25 = 3.528
Wood Studs (90mm)	0.63	-
Gypsum Board (13mm)	0.79	0.79
Inside surface	0.12	0.12

$$R'_{withWood} = 0.03 + 0.14 + 0.11 + 0.63 + 0.079 + 0.12$$
$$= 1.109\ m^2.°\frac{C}{W}$$

$$R'_{withIns} = 0.03 + 0.14 + 0.11 + 3.528 + 0.079 + 0.12$$
$$= 4.007\ m^2.°\frac{C}{W}$$