Q1:

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

$$R_1 = \frac{1}{h_1 A} = \frac{1}{\frac{10W}{m^2 \cdot ℃} \cdot 0.25m \cdot 1m} = 0.4\,℃/W$$

$$R_f = \frac{L_f}{k_f A} = \frac{0.03m}{\frac{0.026W}{m \cdot ℃} \cdot 0.25m \cdot 1m} = 4.615\,℃/W \; R_1$$

$$R_{p_{c_1}} = R_{p_{c_2}} = \frac{L_{p_{c_1}}}{k_p A} = \frac{0.32m}{\frac{0.22W}{m \cdot ℃} \cdot 0.015m \cdot 1m}$$

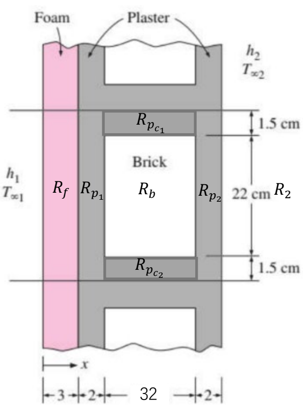
$$= 96.97\,℃/W$$

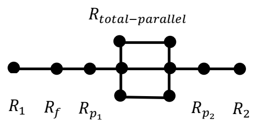
$$R_f = \frac{L_f}{k_f A} = \frac{0.03m}{\frac{0.026W}{m \cdot ℃} \cdot 0.25m \cdot 1m} = 4.615\,℃/W$$

$$R_b = \frac{L_b}{k_b A} = \frac{0.32m}{\frac{0.72W}{m \cdot ℃} \cdot 0.22m \cdot 1m} = 2.02\,℃/W$$

$$\because \frac{1}{R_{total-parallel}} = \frac{1}{R_b} + \frac{1}{R_{p_{c_1}}} + \frac{1}{R_{p_{c_2}}}$$

$$\therefore R_{total-parallel} = 0.66\,℃/W$$





$$R_{p_1} = R_{p_2} = \frac{L_{p_1}}{k_p A} = \frac{0.02m}{\frac{0.22W}{m \cdot ℃} \cdot 0.25m \cdot 1m} = 0.363\,℃/W$$

$$R_2 = \frac{1}{h_2 A} = \frac{1}{\frac{40W}{m^2 \cdot ℃} \cdot 0.25m \cdot 1m} = 0.1\,℃/W$$

$$\therefore R_{total} = R_1 + R_f + R_{p_1} + R_{total-parallel} + R_{p_2} + R_2 = 7.781\,℃/W$$

$$\dot{Q} = \frac{T_1 - T_\infty}{R_{total}} = \frac{20℃ - (-10℃)}{7.781℃/W} = 3.86W$$

We can find that in this situation with the composite wall, simply adding the thickness of the wall doesn't help to increase the thermal resistance of the whole wall.

Q2:

	Wood	Insulation
Outside Air	0.03	0.03
Wood Bevel (13mm*200mm)	0.14	0.14
Polywood(13mm)	0.11	0.11
Urethane Rigif Foam Ins. (90mm)	No	3.528
Wood Studs(90mm)	0.63	No
Gypsum Borad(13mm)	0.079	0.079
Inside Surface	0.12	0.12

$$R_{withwood} = 0.03 + 0.14 + 0.11 + 0.63 + 0.079 + 0.12 = 1.109 \frac{m^2\,℃}{W}$$

$$R_{withinsulation} == 0.03 + 0.14 + 0.11 + 3.528 + 0.079 + 0.12 = 4.007 \frac{m^2\,℃}{W}$$