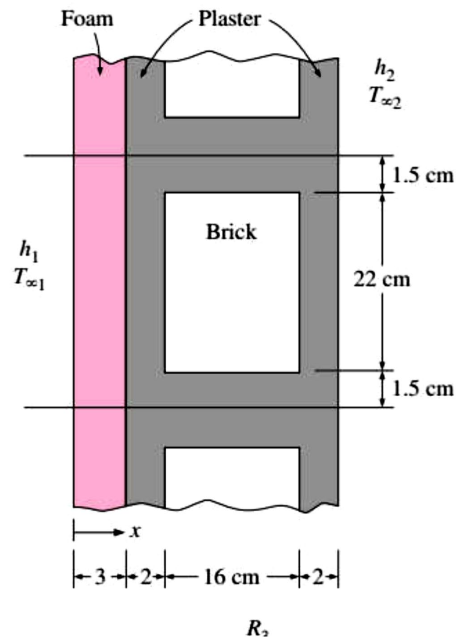
The rate of heat transfer through the composite wall analyzed in class is:

$$\dot{\mathbf{Q}} = \frac{\mathrm{T\infty1 - T\infty2}}{\mathrm{Rtot}} = \frac{20-(-10)\ °C}{6{,}81\ °C/W} = \mathbf{4{,}417\ W}$$



Thickness of the wall = 32cm

$\mathbf{R_i} = \frac{1}{\mathrm{hi\ A}} = \frac{1}{10*0{,}25} = \mathbf{0{,}4\ \frac{°C}{W}}$ (Inner resistance)

$\mathbf{R_f} = \frac{Lf}{\mathrm{kf\ A}} = \frac{0.3}{0.026*0{,}25} = \mathbf{4.615\ \frac{°C}{W}}$ (Foam resistance)

$\mathbf{R_{pc1}} = R_{pc2} = \frac{Lpc1}{\mathrm{kp\ Apc1}} = \frac{0.02}{0.22*0{,}25} = \mathbf{0.36\ \frac{°C}{W}}$ (Plaster resistance)

$R_{pc1} = R_{pc2} = \frac{Lpc1}{\mathrm{kp\ Apc1}} = \frac{0.32}{0.22*0{,}015} = \mathbf{96.97\ \frac{°C}{W}}$ (Plaster resistance in parallel)

$\mathbf{R_b} = \frac{Lb}{\mathrm{kb\ A}} = \frac{0.32}{0.72*0{,}22} = 2.02\ \frac{°C}{W}$ (Brick resistance in parallel)

$$\frac{1}{\mathrm{R\ tot}} = \frac{1}{\mathrm{R\ pc1}} + \frac{1}{\mathrm{R\ b}} + \frac{1}{\mathrm{R\ pc2}} = \frac{1}{96.97} + \frac{1}{2.02} + \frac{1}{96.97} = 0.516\ \frac{W}{°C}$$

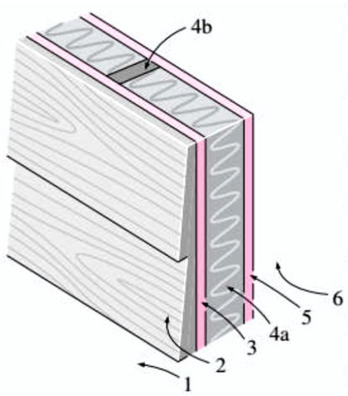
$\mathbf{R}_{\textbf{tot parall}} = \frac{1}{0.516} = 1.938\ \frac{°C}{W}$ (Total resistance in parallel)

$\mathbf{R_o} = \frac{1}{h2\ A} = \frac{1}{50*0,25} = 0,1\ \frac{°C}{W}$ (Outer resistance)

$\mathbf{R_{tot}} = 0.4 + 4.615 + 0.36 + 0.36 + 1.938 + 0.1 = 7,773\ \frac{°C}{W}$ (Total resistance)

$\dot{Q} = \frac{T\infty1 - T\infty2}{Rtot} = \frac{20-(-10)\ °C}{7,773\ °C/W} =$ **3,86 W (Heat transfer through the composite wall)**

By increasing the thickness of the brick from 16 cm to 32 cm, the total parallel resistance increases only of around 1 $\frac{°C}{W}$ so that the heat transfer through the wall decreases of 0,8 W (from 4.417 W to 3.86 W).
We can tell that increasing the thickness of the brick doesn't produce a significant effect in order to reduce the heat transfer, the better solution is increasing the thickness of the foam, which has a way higher resistance.



Determine the overall unit thermal resistance (the R_{value}) 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 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.

$R_{wood\ bevel} + R_{plywood(13mm)} + R_{gypsum\ wallboard} + R_{inside} = 0,479\ \frac{m^2\ °C}{W}$

With insulation

$R_{urethane\ r.\ f.} = 0.98 \times \frac{90}{25} = 3.528\ \frac{m^2\ °C}{W}$

$R_{outside} = 0,03\ \frac{m^2\ °C}{W}$

$\mathbf{R'_{tot}} = 3,528 + 0,339 + 0,03 = \mathbf{4,007}\ \frac{\mathbf{m^2\ °C}}{\mathbf{W}}$

With wood stunds

R $_{plywood}$ = 0,63 $\frac{\mathrm{m}^2\ {}^\circ\mathrm{C}}{\mathrm{W}}$

R $_{outside}$ = 0,3 $\frac{\mathrm{m}^2\ {}^\circ\mathrm{C}}{\mathrm{W}}$

R' $_{tot}$ = 0,63 + 0,479 + 0,3 = **1,379** $\boldsymbol{\frac{\mathrm{m}^2\ {}^\circ\mathrm{C}}{\mathrm{W}}}$