1. First dfinlize the composite wall question by finding the heat transfer rate, and then solve the same question while the thickness of the brick is increased to 32 cm and comment on the results

while the thickness of the brick is increased to 32 cm:

$$R_i = \frac{1}{h_i \times A} = \frac{1}{10 \times 0.25} = 0.4℃/W$$

$$R_f = \frac{l_f}{k_f \times A} = \frac{0.03}{0.026 \times 0.25} = 4.615℃/W$$

$$R_{p_{c1}} = R_{p_{c2}} = \frac{l_{p_{c1}}}{k_p \times A_{p_{c1}}} = \frac{0.32}{0.22 \times 0.015} = 96.97℃/W$$

$$R_b = \frac{l_b}{k_b \times A_b} = \frac{0.32}{0.72 \times 0.22} = 2.02℃/W$$

$$\frac{1}{R_{tot_{parallel}}} = \frac{1}{R_b} + \frac{1}{R_{p_{c1}}} + \frac{1}{R_{p_{c2}}} = \frac{1}{2.02} + \frac{1}{96.97} \times 2 = 0.516W/℃ \rightarrow R_{tot_{parallel}} = 1.94℃/W$$

$$R_{p_1} = R_{p_2} = \frac{l_{p_1}}{k_p \times A_{p_1}} = \frac{0.02}{0.02 \times 0.25} = 0.363℃/W$$

$$R_o = \frac{1}{h_o \times A} = \frac{1}{40 \times 0.25} = 0.1℃/W$$

$$R_{total} = R_o + R_i + 2R_{p_1} + R_{tot_{parallel}} + R_f = 0.1 + 0.4 + 2 \times 0.363 + 1.94 + 4.615$$

$$= 7.781℃/W$$

$$\dot{Q} = \frac{\Delta T}{R_{total}} = \frac{30}{7.781} = 3.86W$$

If the thickness of the brick is 16 cm, we have already calculated the $R_{total} = 6.81℃/W$

Then we can calculate the rate of heat transfer: $\dot{Q} = \frac{\Delta T}{R_{total}} = \frac{20-(-10)}{6.81} = 4.405W$

By comparing the two results, we have the conclusion:

To increase the thickness of the brick which is included in the composite wall can't increase the the thermal resistance obviously and can't decrease the rate of heat transfer obviously.

2. To solve again the simplified wall calculation procedure replacing the glass fiber one with urethane rigi foam and while replacing the fiberboard with plywood and find the two R_unit values

	wood	insulation
Outside Air	0.03	0.03
Wood Bevel	0.14	0.14
Plywood	0.11	0.11
Urethane Rigi Foam (90mm)	NO	0.98x90/0.25
Wood Stud	0.63	NO
Gypsum Board	0.079	0.079
Inside Surface	0.12	0.12

$$R'_{withwood} = 0.03 + 0.14 + 0.11 + 0.63 + 0.079 + 0.12 = 1.109 \text{㎡} \cdot ℃ / W$$

$$R'_{withinsulation} = 0.03 + 0.14 + 0.11 + 0.98 \times 90 / 0.25 + 0.079 + 0.12 = 4.007 \text{㎡} \cdot ℃ / W$$