1. When the thickness of the brick is 16cm

$R_{conv1} = 1/h_1A = 1/(10*0.25) = 0.4\ °C/W$

$R_{foam} = L/kA = 0.03/(0.026*0.25) = 4.62\ °C/W$

$R_{plaster\ side} = L/kA = 0.02/(0.22*0.25) = 0.36\ °C/W$

$R_{plaster\ centre} = L/kA = 0.16/(0.22*0.015) = 48.48\ °C/W$

$R_{brick} = L/kA = 0.16/(0.72*0.22) = 1.01\ °C/W$

$R_{conv2} = 1/h_2A = 1/(40*0.25) = 0.1\ °C/W$

$1/R_{mid} = 1/R_{plaster\ centre} + 1/R_{brick} + 1/R_{plaster\ centre}$

$= 1/48.48 + 1/1.01 + 1/48.48$

$= 1.03\ W/°C$

$R_{mid} = 0.97\ °C/W$

$R_{total} = R_{conv1} + R_{foam} + R_{plaster\ side} + R_{mid} + R_{plaster\ side} + R_{conv2}$

$= 0.4+4.62+0.36+0.97+0.36+0.1$

$= 6.81\ °C/W$

$Q = (T_{\infty 1} - T_{\infty 2})/R_{total} = [20-(-10)]/6.81 = 4.41\ W\ (per\ 0.25m^2)$

$Q_{total} = [4.41/0.25] * (3*5) = 264.6\ W$

If the thickness of the brick is increased to 32cm

$R_{conv1} = 1/h_1A = 1/(10*0.25) = 0.4\ °C/W$

$R_{foam} = L/kA = 0.03/(0.026*0.25) = 4.62\ °C/W$

$R_{plaster\ side}$= L/kA= 0.02/(0.22*0.25)= 0.36 °C/W

$R_{plaster\ centre}$= L/kA= **0.32**/(0.22*0.015)= **96.97** °C/W

R_{brick}= L/kA= **0.32**/(0.72*0.22)= **2.02** °C/W

R_{conv2}= 1/h_2A = 1/(40*0.25)= 0.1 °C/W

$1/R_{mid}$= 1/ $R_{plaster\ centre}$+1/ R_{brick} +1/ $R_{plaster\ centre}$

= 1/**96.97**+ 1/**2.02**+ 1/**96.97**

= **0.52** W/°C

R_{mid} = **1.92** °C/W

R_{total}= R_{conv1}+ R_{foam} + $R_{plaster\ side}$ + R_{mid} + $R_{plaster\ side}$ + R_{conv2}

= 0.4+4.62+0.36+**1.92**+0.36+0.1

= **7.76** °C/W

Q= ($T_{\infty 1}$- $T_{\infty 2}$)/ R_{total}= [20-(-10)]/ **7.76**= **3.87** W (per 0.25m^2)

Q_{total}= [**3.87**/0.25] *(3*5) = **232.2** W

Summary: When we double the thickness of brick, the rate of heat transfer only decreases 12.2%. That means increasing the thickness of the brick has little effect on the rate of heat transfer of an external thermal insulation wall.

2.

	Wood	Insulation
Outside Air	0.03	0.03
Wood Bevel	0.14	0.14
Plywood, 13mm	0.11	0.11
Urethane Rigid Foam, 90mm	No	0.98*90/25=3.528
Wood Studs, 90mm	0.63	No
Gypsum Board, 13mm	0.079	0.079
Inside Surface	0.12	0.12

$R'_{\text{with wood}}$= 0.03+0.14+0.11+0.63+0.079+0.12= **1.109** $m^2°C/W$

$R'_{\text{with insulation}}$= 0.03+0.14+0.11+3.528+0.079+0.12= **4.007** $m^2°C/W$