Third and Fourth Week

Question 1:

$$R_{total} = 0.4 + 4.61 + 0.36 + 0.97 + 0.36 + 0.1$$

$$R_{total} \approx 6.8\ \frac{C^{\circ}}{\mathrm{W}}$$

$$\dot{Q}' = \frac{T_{\infty 1} - T_{\infty 2}}{R_{total}}$$

$$\dot{Q} = \frac{20 - (-10)}{6.8}$$

$$\dot{Q} \approx 4.41\ \mathrm{W}$$

The final amount of the partial heat transfer is for 0.25 m2 area. So, the total heat transfer would be:

$$\dot{Q} = 4.41 \times \frac{3 \times 5}{0.25}$$

$$\dot{Q} \approx 264.6\ \mathrm{W}$$

Question 2:

$$R_{conv\ 1} = \frac{1}{h_1 \times A} = \frac{1}{10 \times [(0.015 + 0.22 + 0.015) \times 1]} = 0.4\ \frac{C^{\circ}}{\mathrm{W}}$$

$$R_{left.plaster} = \frac{L_{plaster}}{k_{plaster} \times A} = \frac{1}{0.22 \times [(0.015 + 0.22 + 0.015) \times 1]} = 0.36\ \frac{C^{\circ}}{\mathrm{W}}$$

$$R_{foam} = \frac{L_{foam}}{k_{foam} \times A} = \frac{0.03}{0.026 \times [(0.015 + 0.22 + 0.015) \times 1]} = 4.61\ \frac{C^{\circ}}{\mathrm{W}}$$

$$\frac{1}{R_{parallel.layers}} = \frac{1}{R_{Plaster.up}} + \frac{1}{R_{brick}} + \frac{1}{R_{plaster.down}}$$

$$\frac{1}{R_{parallel.layers}} = \frac{1}{\frac{L_{plaster.up}}{k_{plaster} \times A}} + \frac{1}{\frac{L_{brick}}{k_{brick} \times A}} + \frac{1}{\frac{L_{plaster.down}}{k_{plaster} \times A}}$$

$$\frac{1}{R_{parallel.layers}} = \frac{1}{\frac{0.32}{0.22 \times 0.015}} + \frac{1}{\frac{0.32}{0.72 \times 0.22}} + \frac{1}{\frac{0.32}{0.22 \times 0.015}}$$

$$\frac{1}{R_{parallel.layers}} = \frac{1}{96.97} + \frac{1}{2.02} + \frac{1}{96.97} = 0.01+0.495+0.01 = 0.515$$

$$R_{parallel.layers} \approx 1.94 \, \frac{C^{\circ}}{\mathrm{W}}$$

$$R_{conv\ 2} = \frac{1}{h_2 \times A} = \frac{1}{40 \times [(0.015+0.22+0.015) \times 1]} = 0.1 \, \frac{C^{\circ}}{\mathrm{W}}$$

Total R:

$$R_{total} = 0.4 + 4.61 + 0.36 + 1.94 + 0.36 + 0.1$$

$$R_{total} \approx 7.8 \, \frac{C^{\circ}}{\mathrm{W}}$$

The heat transfer rate:

$$\dot{Q}' = \frac{T_{\infty 1} - T_{\infty 2}}{R_{total}}$$

$$\dot{Q} = \frac{20 - (-10)}{7.8}$$

$$\dot{Q} \approx 3.85 \mathrm{~W}$$

The final amount of the partial heat transfer is for 0.25 m2 area. So, the total heat transfer would be:

$$\dot{Q} = 3.85 \times \frac{3 \times 5}{0.25}$$

$$\dot{Q} \approx 231 \mathrm{~W}$$

Although the thickness of brick has been doubled in the previous example, the effect on the total value of heat transfer has not been that significant. This is because of law value of brick's thermal conductivity (k= 0.72 m. c).

Question 3:

	Wood Studs	Urethane Rigid Ins
Outside Air	0.03	0.03
Wood Bevel	0.14	0.14
Plywood (13mm)	0.11	0.11
Urethane Rigid Foam	-	0.98*(90/25)= 3.528
Wood Studs	0.63	-
Gypsum Board	0.079	0.079
Inside Surface	0.12	0.12

R wood = 0.03 + 0.14 + 0.11 + 0.63 + 0.079 + 0.12 = 1.109 $m2\ C°$ W

R urethane = 0.03 + 0.14 + 0.11 + 3.528 + 0.079 + 0.12 = 4.007 $m2\ C°$ W

Calculate the overall thermal resistance:

$$\frac{1}{R_{total}} = \frac{1}{R_{wood}} + \frac{1}{R_{ins}}$$

$$R'_{total} = \frac{R_{total}}{\mathrm{A}}$$

$$\frac{1}{\frac{R'_{total}}{A_{total}}} = \frac{1}{\frac{R'_{wood}}{A_{wood}}} + \frac{1}{\frac{R'_{ins}}{A_{ins}}}$$

$$\frac{A_{total}}{R'_{total}} = \frac{A_{wood}}{R'_{wood}} + \frac{A_{ins}}{R'_{ins}}$$

$$R' = \frac{1}{\mathrm{U}}$$

$$U_{total} \times A_{total} = (U_{wood} \times A_{wood}) + (U_{ins} \times A_{ins})$$

$$U_{total} = \left(U_{wood} \times \frac{A_{wood}}{A_{total}}\right) + \left(U_{ins} \times \frac{A_{ins}}{A_{total}}\right)$$

$$U_{total} = (U_{wood} \times 0.25) + (U_{ins} \times 0.75)$$

$$U_{wood} = \frac{1}{R_{wood}} = \frac{1}{1.109} \approx 0.901$$

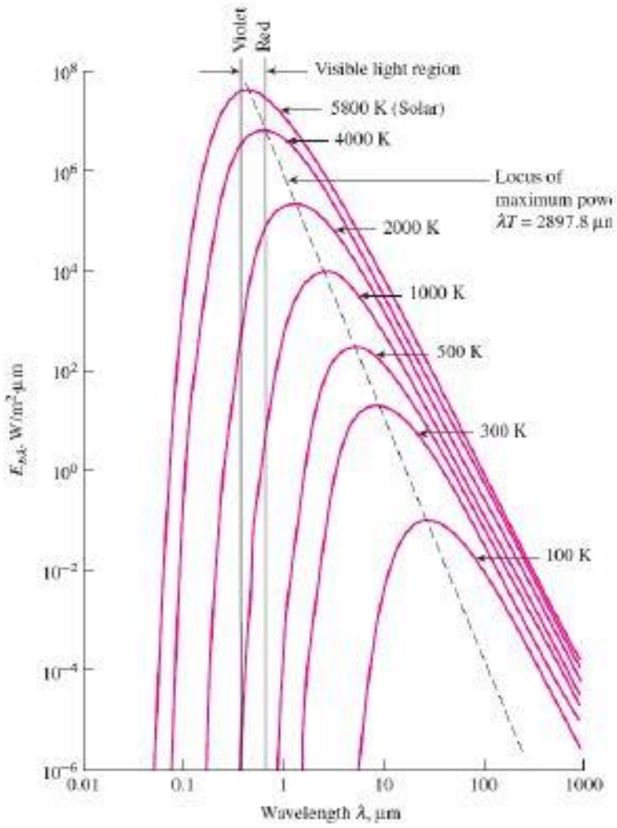
$$U_{wood} = \frac{1}{R_{ins}} = \frac{1}{4.007} \approx 0.250$$

$$U_{total} = (0.901 \times 0.25) + (0.250 \times 0.75) \approx 0.413 \frac{W}{C°m2}$$

$$R'_{total} = \frac{1}{U_{total}} = \frac{1}{0.413} \approx 2.42 \frac{C°m2}{W}$$

$$Q_{total} = U_{total} \times A_{total} \times \Delta T$$

$$Q_{total} = 0.413 \times 100 \times 24 \approx 991 \text{ W}$$



The emitted radiation is a function of wavelength that increased with increasing temperature. It is notable that a larger fraction of the radiation is emitted at shorter wavelength at higher temperatures. Moreover, Surfaces at $T<800$ k emit almost entirely in the infrared region and thus are not visible to the human eye unless they reflect light coming from other sources. The radiation emitted by the sun reaches its peak in the visible light region. Because of that we can see it.