Total heat transfer through wall

Section A (R-unit urethane)

Outside (winter)	0.03
13-mm 200-mm wood bevel lapped siding	0.14
13-mm Polywood	0.11
38-mm 90-mm wood studs	**NO**
90 mm urethane rigid foam	(90/25)*0.98 = 3.528
13-mm gypsum wallboard	0.079
Inside	0.12

R-unit urethane = ∑R_units = 4,007 $m^2.°C/W$

Section B (R-unit wood)

Outside (winter)	0.03
13-mm 200-mm wood bevel lapped siding	0.14
13-mm Polywood	0.11
38-mm 90-mm wood studs	0.63
90 mm urethane rigid foam	**NO**
13-mm gypsum wallboard	0.079
Inside	0.12

R-wood = ∑R_units = 1,109 $m^2.°C/W$

$$\begin{cases} R' = R \times A \\ 1/R'_{tot} = 1/R'_{urethane} + 1/R'_{wood} \end{cases} \Rightarrow \frac{A_{tot}}{R'_{tot}} = \frac{A_{wood}}{R'_{wood}} + \frac{A_{urethane}}{R'_{urethane}}$$

$$\Rightarrow U_{tot} \times A_{tot} = U_{wood} \times A_{wood} + U_U \times A_{urethane}$$

$$\begin{cases} U_{wood} = \frac{1}{1{,}109} \\ U_{urethane} = \frac{1}{4{,}007} \end{cases} \& \begin{cases} \frac{A_{wood}}{A_{tot}} = 0{,}25 \ (25\%) \\ \frac{A_{urethane}}{A_{tot}} = 0{,}75 \ (75\%) \end{cases} \Rightarrow U_{TOT} = \frac{0{,}25}{1{,}109} + \frac{0{,}75}{4{,}007}$$

$$U_{TOT} = 0{,}4126 \ W/m^2.°C$$

$$\Rightarrow Q_{tot} = U_{TOT} \times A_{TOT} \times \Delta T$$
$$= 0{,}4126 \times 2{,}5 \times 50 \times 0{,}8 \times (22-(-2))$$

$$\boxed{Q_{tot} = 990{,}24 \ W}$$

Summary

Definition

As learnt and mentioned in previous classes and assignments, the three methods of heat transfer through mediums are: conduction; through solid materials, convection; through fluids (gases and liquids), and the third is radiation, which is heat transfer though vacuum or void.

Radiation is the most different and special method of heat transfer, because heat transfer doesn't require a medium to move and transfer, but also it occurs through solids and fluids. Radiation is a form of energy that transfers through waves, due to instability of atomic particles producing electromagnetic radiation to which in that way energy is transferred. In other words, electromagnetic (EM) waves are transferring energy, these waves are just as any other waves as in frequency, and wavelength; expressed in this equation:

$$\lambda = \frac{c}{\nu}$$

Where;

ν, is frequency
λ, is wavelength
and *c*, is the speed of propagation of a wave in that medium.

A fact worth mentioning is that the difference of temperature is the factor that identifies the rate of thermal radiation emission.

The range of all types of electromagnetic (EM) radiation is called electromagnetic spectrum, ranging from electrical power waves to the cosmic rays, going through the radio and TV waves, microwaves, infrared, visible, ultraviolet, and x-rays. Concluding to that all bodies emit radiation to a certain level.

The calculation of radiation faces two complications :

- Radiation is sent through different sizes of wavelength
- Radiation happens in all directions

Light

Light is the visible part of the EM spectrum, since our natural light source is the sun, the electromagnetic radiation emitted by the sun is known as solar radiation. Almost half of solar radiation is light (i.e., it falls into the visible range), with the remaining being ultraviolet and infrared.

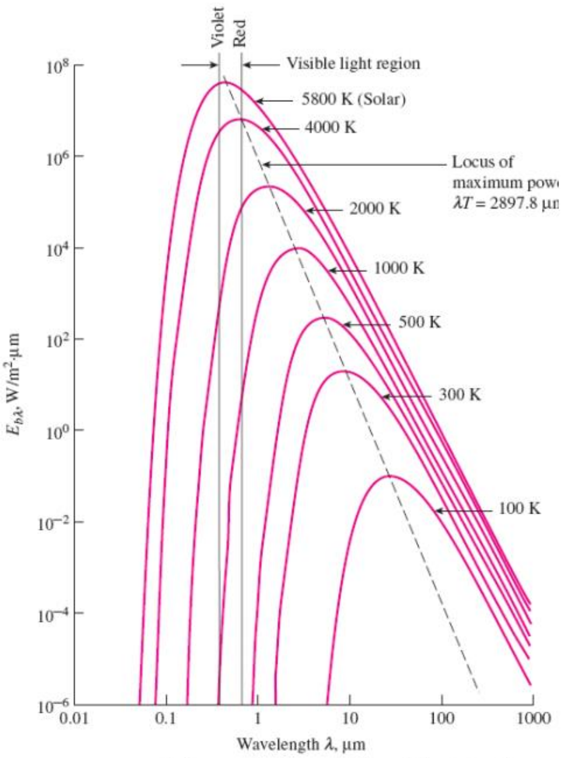
Black Body Radiation

The black body is a cosmic phenomenon, of which is the perfect emitter and absorbent of heat, so the thermal electromagnetic radiation within or surrounding a body in thermodynamic equilibrium with its environment is called the black body radiation. For the calculations, we consider having the same radiation in every direction.

We have :

$$E_b(T) = \sigma T^4 \qquad (\mathrm{W/m^2})$$

We observe that the temperature is notably exponential !



The variation of the blackbody emissive power with wavelength for several temperatures.

- The visible range looks very limited since the diagram is not not showing the real behaviour of the wavelenghts
- The wavelenght is null before a certain value of the temperature
- Radiation increases with increasing temperature, but gets down at a certain max T
- Radiation increases with increasing wavelenght, reaches a peak, and increasing again with increasing wavelenght