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Politecnico di Milano University
M.Arch Sustainable Architecture and Landscape Design
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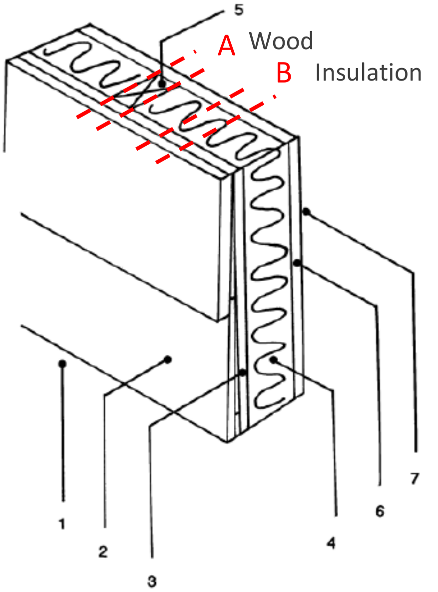
# WEEKLY SUBMISSION - TASK 04

**01.** Complete the modified example of simplified wall calculations that you went through in the assignment of week 3 and find the total heat transfer through wall.
**02.** In 2 pages you should write a summary of what you have learnt in this session about radiation and radiative heat transfer

**ANSWERS**:

## 01.

| | Wood (A Section) | Insulation (B Section) |
|---|---|---|
| Outside | 0.03 | 0.03 |
| Wood Bevel | 0.14 | 0.14 |
| Plywood | 0.144 | 0.11 |
| Urethane Rigid Foam | no | 0.98 x (90/25) = 3.53 |
| Wood Studs | 0.63 | no |
| Gypsum Board | 0.079 | 0.079 |
| Inside Surface | 0.12 | 0.12 |




R in Wood Stud = 0.03 + 0.14 + 0.11 + 0.63 + 0.079 + 0.12 = 1.11 M²°C/W

R in Insulation = 0.03 + 0.14 + 0.11 + 3.53 + 0.079 + 0.12 = 4.00 M²°C/W

$$U\ wood = \frac{1}{Rwood} = \frac{1}{1.11} \boxed{= 0.90\ W/\ °CM^2}$$

$$U\ insulation = \frac{1}{Rinsulation} = \frac{1}{4} \boxed{= 0.25\ W/\ °CM^2}$$

$$U\ total = Uwood \times \frac{A\ wood}{A\ total} + Uins \times \frac{A\ ins}{A\ total}$$

U total = 0.90 x 0.25 + 0.25 x 0.75

U total $\boxed{= 0.4125\ W/\ °CM^2}$

A total = 50 x 2.5 = 125 m²; but 20% is covered by glass, so : 125m² - 20% $\boxed{= 100m^2}$

ΔT = 22 – (-2) $\boxed{= 24\ °C}$

Q total = U total x A total x $\Delta T$

Q total = 0.4125 x 100 x 24

Q total $\boxed{= 990 \text{ W}}$

**02.**

**Introduction:**

Radiation is the most comprehensive heat transfer phenomenon as it can occur in solids, liquids and gases.
One of the main radioation's feature is that it does not need a physical environment other than conduction and convection, and this is very clear when we think of the sun as the main source of light that, by emitting solar radiation in space (vacuum), can transfer its heat to Earth, for example.

**Description:**

We can describe radiation as a release of energy in a form of moving waves or particle streams. These energy-carrying waves are characterized and defined by their frequency and wavelength, as follow:

$\boldsymbol{\lambda = c/v}$ ; where : $\lambda$ is the wavelength
c is the speed of propagation of the wave
v is frequency

This makes a very important conclusion possible: The longer the wavelength, the less power it will carry (and vice versa).

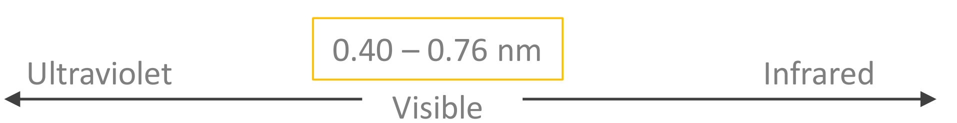
**Thermal Radiation:**

Within the various types of radiation, we find thermal radiation, the only one that is pertinent to heat transfer. It is directly proportional to temperature and take place in any object with temperature above absolute zero or -273 ° C, which means that any element around us is emitting radiation of some level.

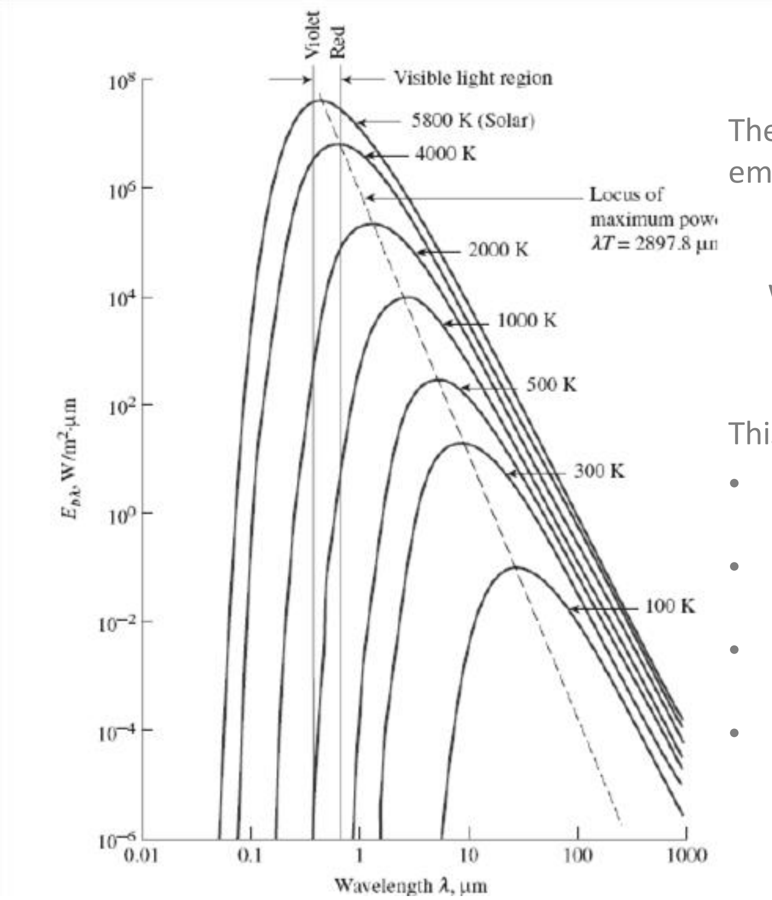
**Light:**

Knowing that different elements emit different levels of radiation, we can classify by wavelength three main types:

- light: visible portion of the electromagnetic spectrum ( from 0.40 to 0.76 nm)
- ultraviolet (UV): shorter wavelength portion and therefore very energy intensive (from 0.01 to 0.40nm)
- infrared (IR): portion with longer wavelength and therefore with less energy (from 0.76 to 100nm)



**Black Body and Black Body Radiation:**
Black bodies are elements designed for the purpose of establishing a benchmark for real elements and surfaces, since any object will have its own characteristics and radiation absorption, emission and reflection rates.
Thus, Black bodies are perfect emitters (evenly emitting energy) and absorbers (capturing any incidence of radiation, regardless of wavelength and direction).




The maximum energy radiation a black body emits is:

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

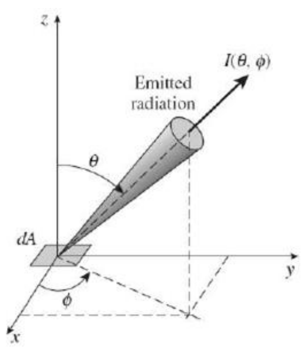
Where: $\sigma$ = Stefan-Boltzmann Constant

This makes possible important conclusions:

- The maximum radiation energy is exponentially changed by temperature.
- Radiation levels increase as temperature levels increase.
- As the temperature increases, the wavelength decreases.
- The emitted radiation is a continuous function of the wavelength.

**Radiation Intensity:**
One of the implications of heat transfer through radiation is that it can happen in many different directions.
To calculate precisely the amount of energy an object or surface receives it is necessary to analyze the distance it is from the energy source and the total area it has.
The total radiation emitted or incident in a specific direction in space is called the Radiation Intensity (I), and for this, it is necessary to study two concepts separately.

**Irradiation (G):**
The radiation flux incidente on a surface from all directions.




**Radiosity(J):**
Total amount of radiation ( emitted + reflected) in a surface or element.