ASSIGMENT 4 (WEEK 4)

Task 1: Complete the modified example of simplified wall calculations from the assignment of week 3 and find the total heat transfer through wall.

Solution:

	Wood	Insulation
Outside air	0.03	0.03
Wood bevel	0.14	0.14
Urethane rigid foam	/	(0.98/25)x90 = 3.53
Plywood	0.11	0.11
Gypsum board	0.079	0.079
Inside surface	0.12	0.12
Wood studs	0.63	/

R'_{wood} =0.03+0.14+0.11 + 0.079 + 0.12 + 0.63 =1.11 $\frac{m2 \cdot °C}{W}$

$R'_{insulation}$ = 0.03+0.14+3.53+0.11+0.079+0.12=4.01 $\frac{m2 \cdot °C}{W}$

$$U_{tot} = U_{ins} * \frac{A_{ins}}{A_{tot}} + U_{wood} * \frac{A_{wood}}{A_{tot}}$$

$$U_{tot} = U_{ins} * 0.75 + U_{wood} * 0.25$$

$$U_{ins} = \frac{1}{R'_{ins}} = \frac{1}{4.01} = 0.2494 \ \frac{W}{m^2°C}$$

$$U_{wood} = \frac{1}{R'_{wood}} = \frac{1}{1.11} = 0.9009 \ \frac{W}{m^2°C}$$

$$U_{tot} = 0.2494 * 0.75 + 0.9009 * 0.25 = 0.18705 + 0.225225 = 0.412275 \ \frac{W}{m^2°C}$$

$$A_{tot} = 50 * 2.5 * 0.8 = 100m^2$$

$$\Delta T = 22 - (-2) = 24°C$$

$$Q_{tot} = U_{tot} * A_{tot} * \Delta T = 989.46 \, W$$

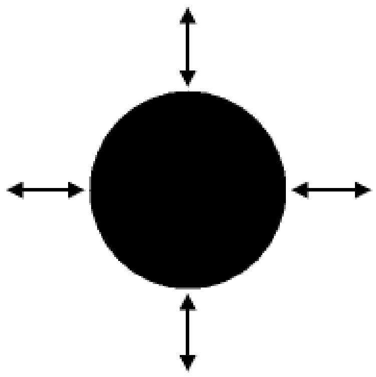
Task 2: In 2 pages write a summary of what you have learnt about radiation and radiative heat transfer.

Our environment is full of energy and radiation and it gets emited into the atmoswhere without us even noticing it. Radiation differs from Conduction and Convection in the sense that it does not require the presence of a material medium to occur. Energy transfer by radiation occurs at the speed of light and radiation can occur between two bodies separated by a medium colder than both bodies.

The radiation characteristics of surfaces can be changed completely by applying thin layers of coatings on them.

Heat transfer through radiation takes place in form of electromagnetic waves mainly in the infrared region. Radiation emitted by a body can be a consequence of thermal agitation of its composing molecules. Radiation heat transfer can be described by reference to the “black body.”

The Black Body



Radiation heat transfer - black body

A blackbody is defined as a perfect emitter and absorber of radiation. At a specified temperature and wavelength, no surface can emit more energy than a blackbody. A blackbody is a diffuse emitter which means it emits radiation uniformly in all direction. Also, a blackbody absorbs all incident radiation regardless of wavelength and direction.

Actual black bodies don't exist in nature - though its characteristics are approximated by a hole in a box filled with highly absorptive material. The emission spectrum of such a black body was first fully described by Max Planck.

A black body is a hypothetical body that completely absorbs all wavelengths of thermal radiation incident on it. Such bodies do not reflect light, and therefore appear black if their temperatures are low enough so as not to be self-luminous. All black bodies heated to a given temperature emit thermal radiation.

The radiation energy per unit time from a **black body** is proportional to the fourth power of the absolute temperature and can be expressed with **Stefan-Boltzmann Law** as

$q = \sigma T^4 A$

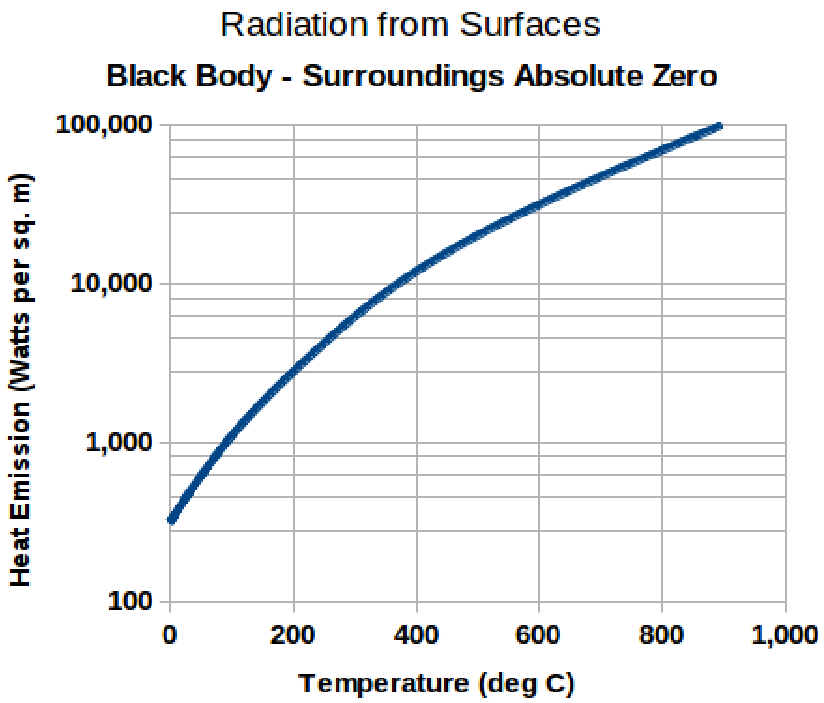
where

q = heat transfer per unit time (W)

σ = 5.6703 10^{-8} (W/m^2K^4) - ***The Stefan-Boltzmann Constant***

T = absolute temperature in kelvins (K)

A = area of the emitting body (m^2)



The Stefan-Boltzmann law gives the total radiation emitted by a blackbody at all wavelengths from 0 to infinity. But we are often interested in the amount of radiation emitted over some wavelength band.