Every surface of an object receives a certain amount of radiations, this flux we call to be the Incident radiation. If we consider the surface di be a diffuse surface, the Incident radiation G correspond to:

G = πI_i

The incident radiation on a surface then splits in three parts: one is absorbed, one is reflected and one is transmitted. So every surface has specific proprieties called absorptivity, reflectivity and transmissivity. They all derive from the Incident radiation following those formulas:

Absorbitivity = $\frac{\text{Absorbed radiation}}{\text{Incident radiation}} = \frac{Gabs}{\text{G}}$

Reflectivity = $\frac{\text{Reflected radiation}}{\text{Incident radiation}} = \frac{Gref}{\text{G}}$

Transmissivity = $\frac{\text{Transmitted radiation}}{\text{Incident radiation}} = \frac{Gtr}{\text{G}}$

A black body is an idealized body that does not transmit any part of the incoming radiation. For studying the radiative proprieties of objects, its useful compare them to a black body, which is a perfect absorber/emitter of energy.
Emissivity is quantity that makes a straight comparison and state how much a surface behaves closely to a black body. More precisely Emissivity means the ratio of the radiation emitted by the surface at a given temperature to the radiation emitted by a blackbody at the same temperature. We assume the emissivity of a black body is **$\varepsilon = 1$** while in a real surface is **$0 < \varepsilon < 1$.**
The emissivity of a surface varies also with direction and wavelength. A diffuse surface is an idealized surface where te emissivity doesn't depend on the direction. The emissivity of a surface at a specified wavelength is called spectral emissivity (ε_λ) The emissivity in a specified direction is called directional emissivity (ε_Θ)
There is a relationship between the absorbtivity (α) and emissivity (ε): the **Kirchhoff's Law** says: the total hemispherical emissivity of a surface at temperature T is equal to its total hemispherical absorptivity for radiation coming from a blackbody at the same temperature.

$$G_{\text{abs}} = \alpha G = \alpha\sigma T^4 = E_{\text{emit}} = \varepsilon\sigma T^4$$

The transmittion of energy between two surfaces depends on their proprieties, the temperatures the view factor. The view factor is a quantity that describes only the geometrical condition of the two surfaces: it depends on their Areas, their distances and orientation.

$$F_{12} = F_{A_1 \to A_2} = \frac{\dot{Q}_{A_1 \to A_2}}{\dot{Q}_{A_1}} = \frac{1}{A_1} \int_{A_2} \int_{A_1} \frac{\cos \theta_1 \cos \theta_2}{\pi r^2} \, dA_1 \, dA_2$$

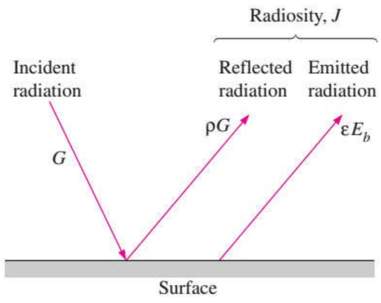
The reciprocity law says that the view factor doesn't chage whether it is considered from the surface 1 to surface 2 or from surface 2 to surface 1

$A_1F_{12} = A_2F_{21}$

The heat exchange between two black surfaces surfaces ($\varepsilon = 1$) is given by the difference between the radiation leaving the entire surface 1 to the surface 2 and the radiation leaving all the surface 2 to the surface 1.

$\dot{Q}_{1\text{->}2} = A_1 E_{b1} F_{1\text{-}2} - A_{21} E_{b2} F_{2\text{-}1}$ With the reprocity law: $\dot{Q}_{1\text{->}2} = A_1 \; F_{12} \, \sigma \, (T_1^4 \; - T_2^4)$

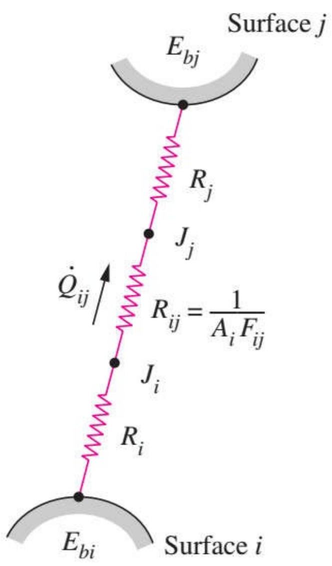
The heat exchange between two diffuse gray surfaces is given by the difference between the radiosity leaving the surface one and the radiosity leaving the surface 2



$$\dot{Q}_i = A_i\left(J_i - \frac{J_i - \varepsilon_i E_{bi}}{1 - \varepsilon_i}\right) = \frac{A_i \varepsilon_i}{1 - \varepsilon_i}(E_{bi} - J_i)$$

Where we know that $J_i = \varepsilon_i B_{bi} + (1 - \varepsilon_i) \, G_{bi}$

Electric analogy: The heat transfer between two surfaces can be seen as a succession of different resitences.



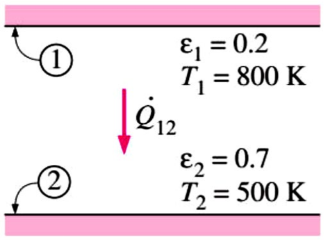
$\dot{Q}_{1\text{->}2} = A_1 J_1 F_{1\text{-}2} - A_2 J_2 F_{2\text{-}1}$

$$\dot{Q}_{i \to j} = \frac{J_i - J_j}{R_{i \to j}}$$

$$R_{i \to j} = \frac{1}{A_i \, F_{i \to j}}$$

Exercise:

Calculate the heat exchange between the two parallel plates:



$$\dot{Q}_{12} = \frac{A\sigma(T_1^4 - T_2^4)}{\frac{1}{\varepsilon_1} + \frac{1}{\varepsilon_2} - 1}$$

$\dot{\mathbf{Q}}_{\mathbf{12}} = A \, \frac{5.670 * 10^{-8} * (800^4 - 500^4)}{\frac{1}{0.2} + \frac{1}{0.7} - 1} = \mathrm{A} \, \frac{19680{,}57}{5.4286}$ = **3625,35 x A [W]**

With the two emissivities of the plates are 0.1:

$\dot{\mathbf{Q}}_{\mathbf{12}} = A \text{ x } \frac{5.670 * 10^{-8} * (800^4 - 500^4)}{\frac{1}{0.1} + \frac{1}{0.1} - 1} = \mathrm{A} \text{ x } \frac{19680{,}57}{19}$ = **1035,82 x A [W]**

With the same area and variation of temperature, increasing the emissivity it also increases the heat exchange between the two parallel plates