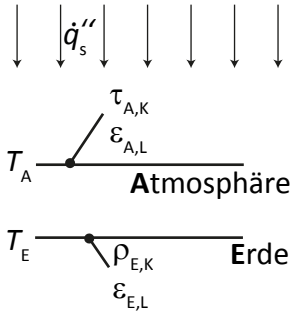
Greenhouse gas effect

For a simplified description of the green house effect, the total atmosphere can be treated as an infinitely thin surface with temperature T_{A}. The atmosphere is fully transmissible for sun radiation and black for radiation emitted from the earth. Sun radiation is assumed to be short–wave, while radiation from the earth and the atmosphere are assumed to be long–wave. The earth's surface (temperature T_{E}) has a reflectivity $\rho_{\mathrm{E,S}}$ in the short–wave spectral range, but is black in the long–wave spectral range. The incident radiation of the sun is $\dot{q}''_S$.

Calculate the unknown temperatures T_{A} and T_{E}.



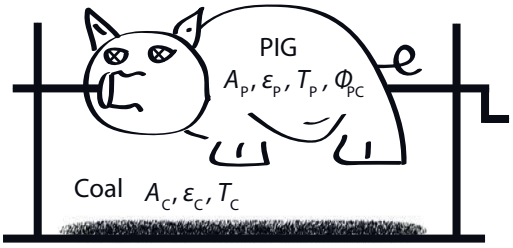
Hint: The distance earth's surface - atmosphere is negligibly small compared to the earth's radius.

Given variables:

- Heat flux of the sun, $\dot{q}''_S = 343.25\,\mathrm{W/m^2}$
- The earth's reflectivity in the short–wave spectrum, $\rho_{E,S} = 0.3$
- The atmosphere's transmissivity in the short–wave spectrum, $\tau_{A,S=1}$
- The atmosphere's emissivity in the long–wave spectrum, $\varepsilon_{A,L} = 1$
- The earth's emissivity in the long–wave spectrum, $\varepsilon_{E,L=1}$

Grilling pig

A perfectly round pig is to be grilled "Rotisserie Style" using coal. Determine the surface temperature of the pig T_P in function of the given variables.



Given variables:

- Temperature of the coal, T_C
- Emissivity of the coal, $\varepsilon_\mathrm{C} = 1$
- Emissivity of the pig, ε_P
- View factor pig to coal, Φ_PC
- Surface of the charcoal bed, A_C
- Surface of the pig, A_P

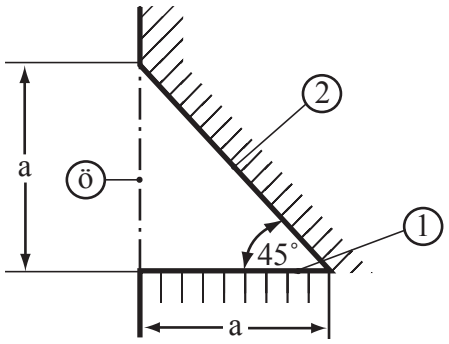
Hints:

- It is a steady state problem (stationary).
- The pig has an isothermal surface temperature.
- The pig acts as a grey body radiator.
- The pig does not see itself, i. e. $\Phi_\mathrm{PP} = 0$.
- Radiation from the sun and the environment are not to be considered.
- Neglect heat conduction effects.

Radiation within a wedge-shaped opening

For an infinitely long opening with a wedge-shaped cross section, the following data are known:

The surface (1) is $a = 30\,\text{cm}$ wide, has an emission coefficient of $\varepsilon_1 = 1$ and a temperature of $T_1 = 1000\,\text{K}$. The side comprising the opening, too, is 30 cm wide and perpendicular to surface (1). Surface (2) is a grey body and adiabatically insulated at the back. The space surrounding the opening can be considered to be a black body with a temperature of 0 K. Influences due to convection shall be disregarded.



Tasks:

a) Determine the view factors $\Phi_{1,2}, \Phi_{2,1}, \Phi_{1,\text{o}}, \Phi_{2,\text{o}}$

b) Determine the energy loss of surface (1) $\dot{q}'_{1,V}$ and the opening $\dot{q}'_{\text{o},V}$ for a unit length of the opening.

c) Determine the temperature T_2 of surface (2).