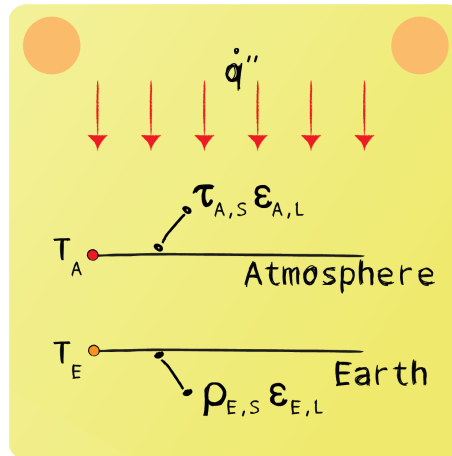


## Exam Preparation Radiation 07

A simplified description of the green house effect, the total atmosphere can be treated as an infinitely thin surface. 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 has a reflectivity  $\rho_E$  in the short-wave spectral range, but is black in the long-wave spectral range. The incident radiation of the sun is  $\dot{q}''$ . Both temperatures  $T_E$  and  $T_A$  are unknown. Give an expression for the unknown temperature  $T_A$ .



Balance around area A:

$$\begin{aligned} -2\sigma T_A^4 + \sigma T_E^4 &= 0 \\ \rightarrow T_E^4 &= 2T_A^4 \end{aligned}$$

Balance around area E:

$$\sigma T_A^4 - \sigma T_E^4 + (1 - \rho_{E,S}) \dot{q}'' = 0$$

Substitution of  $T_E^4 = 2T_A^4$  into the balance around area E and rewriting:

$$\begin{aligned} T_A &= \sqrt[4]{\frac{(1 - \rho_{E,S}) \dot{q}''}{\sigma}} \\ T_E &= \sqrt[4]{\frac{2 \cdot (1 - \rho_{E,S}) \dot{q}''}{\sigma}} \end{aligned}$$