705.

Problem 49.11 (RHK)

An oven with an inside temperature $T_0 = 215^0\text{C}$ *is in a room with a temperature of* $T_r = 26.2^0\text{C}$. *There is a small opening of area* $A = 5.20\ \text{cm}^2$ *in one side of the oven. We have to find the net power transferred from the oven to the room. We may consider both oven and room as cavities with* $\varepsilon = 1$.

Solution:

The total radiation power per unit area emitted from a cavity aperture is given by the Stefan-Boltzmann law, which states that

$I(T) = \sigma T^4$,

$\sigma = 5.670 \times 10^{-8}\ \text{W m}^{-2}\ \text{K}^{-4}$.

Temperature of the oven is

$T_{oven} = (273.15 + 215)\ \text{K} = 488.15\ \text{K}$,

And the temperature of the room is

$T_{room} = (273.15 + 26.2)\ \text{K} = 299.35\ \text{K}$.

As both oven and the room are assumed to be cavities with emissivity $\varepsilon = 1$, the net power transferred to the room per unit time from the hole in the oven of area $A = 5.20\ \text{cm}^2$ will be

$$\begin{aligned} \mathsf{E} &= 5.670 \times 10^{-8} \times 5.20 \times 10^{-4} \times \left(488.15^4 - 299.35^4\right)\ \text{W} \\ &= 1.44\ \text{W}. \end{aligned}$$