Answer to the question #57425, Physics / Molecular Physics | Thermodynamics

Person with External Body Temperature 35°C Is Present in a Room at Temperature 25°C. Assuming the Emissivity of the Body of the Person to Be 0.5 and Surface Area of the Body of the Person as 2.0 m^2, Calculate the Radiant Power of the Person.

Answer:

The solution can be found using the Stefan-Boltzmann law

$\mathrm{P} = \frac{\mathrm{Q}}{\mathrm{t}} = \mathrm{eS}\sigma\mathrm{T}^4$, where Q - the amount of heat radiated, t - time, P – power, σ=5.67 × 10^{-8} J/s m^2 K^4 is a Stefan-Boltzmann constant, S=2.0 m^2 - surface area, a person's emissivity e=0.5, T –temperature in Kelvins.

The person radiates energy at a rate

$$\mathrm{P_{body}} = 0.5 \cdot 2 \cdot 5.67 \times 10^{-8} \cdot (35 + 273)^4 = 510.253 \text{ J/s } (1 \text{ J/s} = 1\mathrm{W})$$

However, the person is also absorbing heat radiated by the surroundings. If the person and the surroundings were at the same temperature, the two rates would be equal, so the rate of heat absorption must be the same expression, but calculated using the temperature of the surroundings,

$$\mathrm{P_{room}} = 0.5 \cdot 2 \cdot 5.67 \times 10^{-8} \cdot (25 + 273)^4 = 447{,}145 \text{ J/s } (1 \text{ J/s} = 1\mathrm{W})$$

$$\mathrm{P} = \mathrm{P_{body}} - \mathrm{P_{room}} = 510.253 - 447{,}145 = 63{,}108 \text{ J/s } (1 \text{ J/s} = 1\mathrm{W})$$