Answer on Question #43370-Physics-Other

You have heard that covering your head is an excellent way to keep warm during cold days. Let's model the head as a 17 diameter, 20 cm tall cylinder with a flat top. If the body's surface temperature is 35 0C, what is the rate of heat loss from the top of the head only on a chilly 4 0C day? Assume all skin color regardless of color behaves like a black body in infrared where the radiation loss occurs.

Solution

If a hot object is radiating energy to its cooler surroundings the net radiation heat loss rate can be expressed as

$$q = \varepsilon\sigma\left(T_h^4 - T_c^4\right)A_C,$$

where T_h is hot body absolute temperature, T_c is cold surroundings absolute temperature, A_c is area of the object, ε is emissivity of the object (one for a black body), $\sigma = 5.67 \cdot 10^{-8}\ \left(\frac{W}{m^2K^4}\right)$ is The Stefan-Boltzmann Constant.

An area of tall cylinder is

$$A = 2\pi r(r + h).$$

The body's surface temperature is $T_h = 273 + 35 = 308K$. The cold surroundings absolute temperature is $T_c = 273 + 4 = 277K$.

The rate of heat loss is

$$q = 1 \cdot 5.67 \cdot 10^{-8}\left(\frac{W}{m^2K^4}\right)(308^4 - 277^4)K^4 \cdot 2\pi \cdot 0.085(0.085 + 0.2)(m^2) = 27\ W.$$

Answer: $27\ W$.