Tutorial on Radiation

1. After sunset, radiant energy can be sensed by a person standing near a brick wall. Such walls frequently have surface temperatures around 44°C, and typical brick emissivity values are on the order of 0.92. What would be the radiant thermal flux per square foot from a brick wall at this temperature?

2. The total incident radiant energy upon a body which partially reflects, absorbs, and transmits radiant energy is 2200 W/m^2. Of this amount, 450 W/m^2 is reflected and 900 W/m^2 is absorbed by the body. Find the transmissivity τ.

3. For a blackbody maintained at 115°C, determine (a) the total emissive power, (b) the wavelength at which the maximum monochromatic emissive power occurs, and (c) the maximum monochromatic emissive power.

4. The sun's surface temperature is 5700 K.

   a. How much power is radiated by the sun?

   b. Given that the distance to earth is about 200 sun radii, what is the maximum power possible from a one square kilometer solar energy installation?

5. If surface body temperature is 90 °F.

   a. How much radiant energy in Wm^{-2}

   b. would your body emit?

   c. What is the peak wavelength of emitted radiation?

   d. What is the total radiant energy emitted by your body in Watts? Note: The average adult human male has a body surface area of about 1.9 m^2 and the average body surface area for a woman is about 1.6 m^2.

6. The filament of a light bulb is cylindrical with length $l = 20$ mm and radius $r = 0.05$ mm. The filament is maintained at a temperature $T = 5000$ K by an electric current. The filament behaves approximately as a black body, emitting radiation isotropically. At night, you observe the light bulb from a distance $D = 10$ km with the pupil of your eye fully dilated to a radius $\rho = 3$ mm.

(a) What is the total power radiated by the filament?

(b) How much radiation power enters your eye?

(c) At what wavelength does the filament radiate the most power?

(d) How many radiated photons enter your eye every second? You can assume that the average wavelength for the radiation is $\lambda = 600$ nm.