

HOMEWORK
Radiation and the earth's energy budget

Read Chapter 4 of W&H

1. For a spherical 100 W light bulb with a radius of 5 cm, calculate the following: (a) the radiant flux; (b) the irradiance at the surface of the bulb; (c) the irradiance at a distance of 10 m. [3]
2. What is the irradiance of a person with a normal body temperature? At what wavelength does the maximum emission occur? For a person of average size estimate their radiant flux. [3]
3. Using the blackbody emission equation (Planck function) defined in the lectures, i.e.

$$B_{\lambda} = \frac{c_1 \lambda^{-5}}{\pi (e^{c_2/\lambda T} - 1)}$$

where $c_1 = 3.74 \times 10^{-16} \text{ W m}^{-2}$ and $c_2 = 1.45 \times 10^{-2} \text{ m K}$ are fixed constants,

- (a) estimate the wavelength of maximum emission for a black-body temperature of 6000 K.
 - (b) calculate the radiant flux for a sphere of this substance with a temperature of 6000 K and a radius of 6000 km. [3]
4. What fraction of the flux of energy emitted by the sun does the earth intercept? [2]
 5. Using the Stefan-Boltzmann equation discussed in the lectures, estimate the difference in emitted longwave irradiance in W m^{-2} between a clear, vaporless sky (with a surface temperature of 300 K) and a cloudy sky (with a cloud temperature of 220 K). You should assume that the surface and the cloud both act as black bodies. Place your result in the context of the atmospheric greenhouse effect. [2]
 6. Given the way in which ozone is produced in the stratosphere, estimate what would happen to the profile of ozone if the atmosphere's density scale height increased. How might this change the temperature profile in the stratosphere? [2]

Question 6 is carried over from previous homework.