

Problems

1. Calculate the wavelength of a photon with a photon energy of 2 eV. Also, calculate the wavelength of an electron with a kinetic energy of 2 eV.
2. Consider a beam of light with a power of 1 Watt and a wavelength of 800 nm. Calculate a) the photon energy of the photons in the beam, b) the frequency of the light wave and c) the number of photons provided by the beam in one second.
3. Show that the spectral density, u_w (equation 1.2.4) peaks at $E_{ph} = 2.82 kT$. Note that a numeric iteration is required.
4. Calculate the peak wavelength of blackbody radiation emitted from a human body at a temperature of 37°C.
5. Derive equations (1.2.9) and (1.2.10).
6. What is the width of an infinite quantum well if the second lowest energy of a free electron confined to the well equals 100 mV?
7. Calculate the lowest three possible energies of an electron in a hydrogen atom in units of electron volt. Identify all possible electron energies between the lowest energy and -2 eV.
8. Derive the electric field of a proton with charge q as a function of the distance from the proton using Gauss's law. Integrate the electric field to find the potential $f(r)$:

$$f(r) = \frac{q}{4\pi \epsilon_0 r}$$

Treat the proton as a point charge and assume the potential to be zero far away from the proton.

9. Prove that the probability of occupying an energy level below the Fermi energy equals the probability that an energy level above the Fermi energy and equally far away from the Fermi energy is not occupied.