Blackbody Distribution Function

The radiant power emitted per unit area by an object at temperature T at wavelengths between λ and λ+dλ is given by the Plank law, where ϵ(λ,T) is the object emissivity:

$$M_{e,\lambda}(\lambda,T)d\lambda = \epsilon(\lambda,T)\frac{2\pi hc^2 d\lambda}{\lambda^5[e^{hc/\lambda kT}-1]}$$

a. Plot $M_{e,\lambda}$ as a function of λ for 10nm<λ<10000 nm for an object with ϵ(λ,T)=1 ("blackbody") at T=5000K. Use semilogx and loglog plot.

b. What is the wavelength of maximum energy emission?

c. How much total power is emitted between λ=550nm and λ=560nm from a 1cm^2 area of this object?

d. Find an expression for $M_{p,\lambda}$dλ, the number of photons emitted per unit area between λ and λ+dλ by an object at temperature T with emissivity ϵ(λ,T).

e. Plot $M_{p,\lambda}$ as a function of λ for 10nm<λ<10000 nm for an object with ϵ(λ,T)=1 ("blackbody") at T=5000K. Use semilogx and loglog plots.

f. What is the wavelength at which the maximum number of photons are emitted.

g. How many photons/second are emitted between λ=550nm and λ=560nm from a 1cm^2 area of this object?

h. Find an expression for $M_{e,\nu}$ where $M_{e,\nu}$dν is the radiant power emitted per unit area by an object at temperature T between frequency ν and ν+dν.

i. Plot $M_{e,\nu}$ as a function of ν from ν_1=c/10000nm to ν_2=c/100nm for an object with ϵ(λ,T)=1 ("blackbody") at T=5000K. Use semilogx and loglog plots.

j. What is the frequency of maximum energy emission? What wavelength does this frequency correspond to.

k. How much total power is emitted between ν=c/550nm and ν=c/560nm from a 1cm^2 area of this object?

l. Find an expression for $M_{p,\nu}$dν, the number of photons emitter per unit area between ν and

$\nu+d\nu$ by an object at temperature T with emissivity $\epsilon(\nu,T)$.

m. Plot $M_{p,\nu}$ as a function of ν from ν_1=c/10000nm to ν_2=c/100nm for an object with $\epsilon(\nu,T)=1$ ("blackbody") at T=5000K. Use semilogx and loglog plots.

n. At what frequency is the maximum number of photons emitted? What wavelength does this frequency correspond to?

o. How many photons/second are emitted between ν=c/550nm and ν=c/560nm from a $1cm^2$ area of this object?

p. It is often stated that the human eye, with a maximum sensitivity at around 550nm, has evolved to be most sensitive at the wavelength of the maximum output of the sun (modeled as a blackbody of T=5000K). Based on the results of this exercise, would you have any misgivings about this statement?