Exercise 1

Show that, in terms of the wavelength interval, the Rayleigh Jeans' law can be expressed as

$$u(\lambda)d\lambda = \frac{8\pi kT}{\lambda^4}d\lambda$$

Exercise 2

Prove Eqn. (3).

(Hint : Treat β as a continuous variable and show that the right hand side is $-\frac{\partial}{\partial\beta}\ln\sum\exp(-nh\nu\beta)$).

Using $\bar{\varepsilon}$ to be the average energy of the mode instead of kT, the energy density is given, instead of Eqn. (2), by

$$u(\nu)d\nu = \frac{8\pi h\nu^3}{c^3}\frac{1}{e^{h\nu\beta}-1}d\nu \quad (4)$$

Exercise 3

Show that Eqn. (4) reduces to Rayleigh - Jeans' expression for long wavelengths i.e. as $\nu \to 0$. [Hint : use $e^x \approx 1+x$ for $x \ll 1$]

Exercise 4

Show that, in terms of wavelength, the expression for radiant intensity is given by

$$I(\lambda)d\lambda = \frac{2\pi hc^2}{\lambda^5}\frac{1}{\exp(hc\beta/\lambda)-1} \quad (5)$$

Exercise 5

A spherical black body of radius 2m is at 27 ^{o} C. Find the power radiated.

[Ans. 22077 watts]

Exercise 6

Total energy radiated from a blackbody source is collected for one minute and is used to heat a quantity of water. The temperature

of water is found to increase from 20°C to 20.5°C. If the absolute temperature of the blackbody were doubled and the experiment repeated with the same quantity of water at 20°C, find the temperature of water.(Ans. 28 $^{\circ}$C)

Exercise 7

Using the above distances and the calculated temperature of the sun, estimate the equilibrium temperature of the earth.

(Hint : First determine the total amount of power collected by the earth by observing that πR_E^2 section of the earth collects all the power falling on the earth. In equilibrium, this amount is equal to the power radiated from the earth..Ans. 278.7 K.)

Exercise 8

The surface temperature of the sun is about 6000 K. What is the wavelength at which the sun emits its peak radiation intensity ?

(Ans. 483 nm)

Exercise 9

Taking the mean temperature of the surface of the earth to be 10 $^{\circ}$C, calculate the wavelength at which the earth emits maximum radiation.

(Ans. 10 μ, i.e. the earth emits mostly in infrared.)

Exercise 10

What fraction of the radiant energy in a cavity is below λ_{max} ?

(Ans. 0.25)

Exercise 11

The black body spectrum of an object A has its peak intensity at 200 nm while that of another object of same shape and size has its peak at 600 nm. Compare radiant intensities of the two bodies.

(Ans. A radiates 81 times more than B)