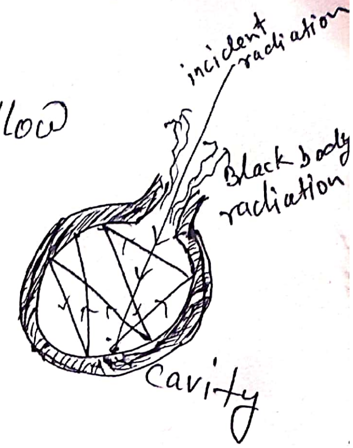
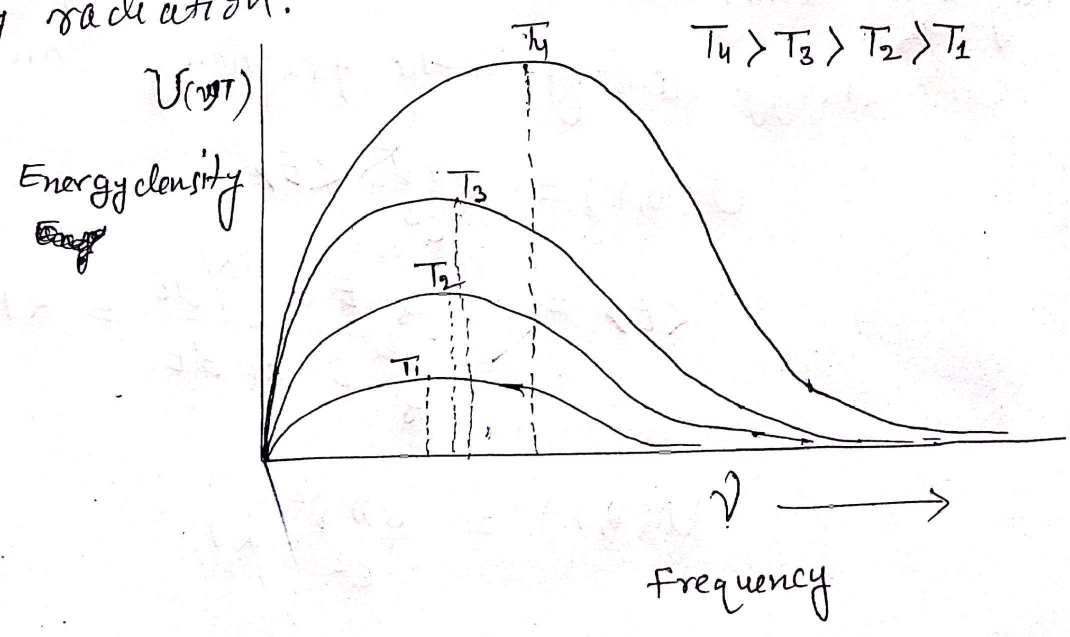
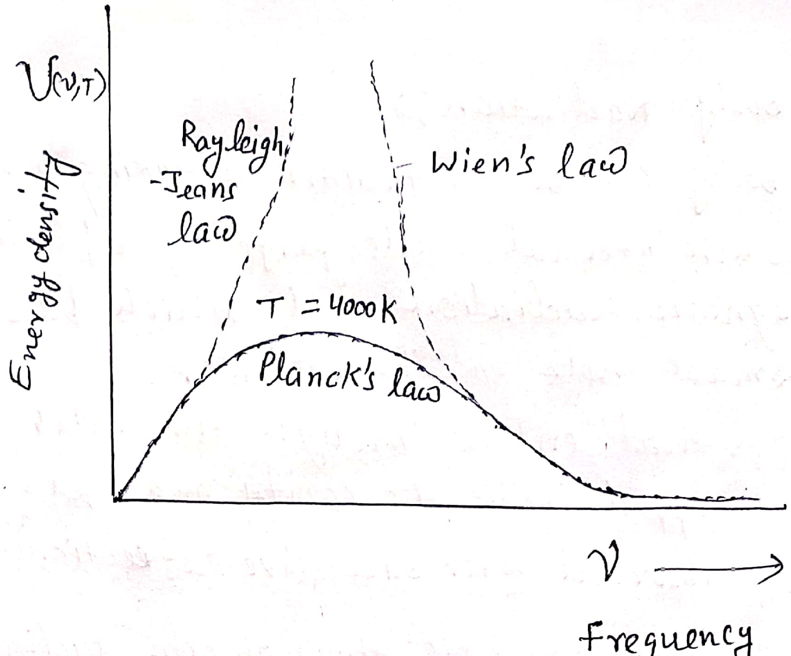
Black Body Radiation :→



A black body can be constructed by taking a hollow cavity whose internal walls perfectly reflected electromagnetic radiation and which has a very small hole on its surface.
Radiations that enters through the holes will be trapped inside the cavity and gets completely absorbed after successive reflections on the inner surface of the cavity. The hole thus absorbs radiation like a black body. When this cavity is heated to a temperature T, the radiation that leaves the hole is black body radiation. As the temperature increases the hole will eventually begin to glow. To understand the radiation inside the cavity, one needs simply to analyze the spectral distribution of the radiation coming out of the hole. The radiation emitted by a black body when hot is called black body radiation.





Wien's Law :-

The energy density perunit frequency of the emitted black body radiation is given as

$$U(\nu,T) = A\nu^3 e^{-\beta\nu/T}$$

Wien's formula explain well at high frequency but to fail ~~to~~ explain low frequency.

Rayleigh-Jean's law :-

The energy density in the frequency range ν and $\nu+d\nu$

$$U(\nu,T) = \frac{8\pi\nu^2}{c^3}\langle E\rangle$$

$$\langle E\rangle = \frac{\int_0^\infty E e^{-E/KT} dE}{\int_0^\infty e^{-E/KT} dE} = KT$$

$$U(\nu,T) = \frac{8\pi\nu^2}{c^3} KT$$

Rayleigh-Jean's law explain low frequency well, but to fail to explain high frequency.

Rayleigh-Jean's law and wien's law fail to explain complete distribution of energy or complete range of frequencies.

Planck's Law :- Planck's state that inside the black body, molecules vibrates and perform simple harmonic motion with all possible frequencies, called oscillators.

Oscillators can not emit or absorb the energy continuously but the oscillator of frequency 'ν' only can emit or absorb the energy of magnitude '$h\nu$'.

$$E = h\nu$$

$$\because \nu = \frac{c}{\lambda}$$

$$E = \frac{hc}{\lambda}$$

$\nu \rightarrow$ Frequency

$h \rightarrow$ Planck's constant

$E \rightarrow$ Energy

for n oscillator the energy is

$$E = nh\nu$$

where $n = 0, 1, 2, 3, \ldots$

$h\nu$ is the energy of a (quantum of radiation)

Planck's assume that the energy of an oscillator is quantized. The average energy can be obtained by a discrete summation corresponding to the discreteness of the oscillators.

average energy $$\langle E \rangle = \frac{\sum_{n=0}^{\infty} nh\nu \, e^{-nh\nu/KT}}{\sum_{n=0}^{\infty} e^{-nh\nu/KT}} = \frac{h\nu}{e^{\frac{h\nu}{KT}} - 1}$$

Now the energy density per unit frequency of the radiation emitted from the hole of cavity is given by

$$U(\nu, T) = \frac{8\pi\nu^2}{c^3} \frac{h\nu}{e^{\frac{h\nu}{KT}} - 1}$$

This is known as Planck's distribution. It gives an exact fit to the various experimental radiation distribution.

Planck's explained black body radiation exactly.