GIRIDHAR KUMAR.

Date
18/02/26

SEM-VI paper-II unit-03.

* Planck's Law of Blackbody Radiation.

The spectral energy density per unit frequency.

$$u(\nu) = \frac{8\pi h\nu^3}{c^3} \times \frac{1}{e^{h\nu/KT} - 1}$$

or in wavelength form.

$$u(\lambda) = \frac{8\pi hc}{\lambda^5} \frac{1}{e^{hc/\lambda KT} - 1}$$

where

$K = 1.38 \times 10^{-23}$ J/K

T = temperature

c = speed of light

⇒ Physical Meaning of Planck's Formula

It has two parts:-

(1) $\frac{8\pi\nu^2}{c^3}$ (Number of modes in cavity)

(2) $\frac{h\nu}{e^{h\nu/KT} - 1}$ (Average energy per oscillator)

Planck's replaced classical average energy KT with quantum expression.

* Deduction of important Laws from Planck's Law

(A) Rayleigh - Jeans Law (Low frequency Limits)

When:-

$h\nu << KT$

using expression

$e^x \simeq 1 + x$

Then $u(\nu) \simeq \frac{8\pi\nu^2}{c^3} KT$

Which is Rayleigh - Jeans law.
So classical theory is valid only when energy quanta are small.

(B.) Wien's Distribution Law (High frequency Limits)

When

$h\nu >> KT$

Then

$e^{h\nu/KT} >> 1$

So

$$u(\nu) \simeq \frac{8\pi h\nu^3}{c^3} e^{-h\nu/KT}$$

This is Wien's distribution Law.
Thus ~~is~~ Wien's Law is a high-frequency approximation of Plancks law.

—— x x x ——