~~B.Sc Part I (physics Hons)~~
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U.G Sem VI
MJC - 11

Ques :→ Derive Wien's Displacement law ?

Ans :→ **Wein's Displacement Law :→**

From thermodynamics considerations, Wein's has shown that the product of the wavelength corresponding to maximum energy λ_m and the absolute temperature is constant i.e

$$\lambda_m \cdot T = \text{constant} \quad \text{---------- (1)}$$

This is called wein's displacement constant and has a value 0.2892 cm K

In laboratory, it is evident that when a blackened platinum wire is electrically heated, it becomes dull red at about 500°c, cherry red at about 900°c, orange red at 1100°c and yellow at 1250°c, and finally becomes white at 1600°c. This shows that as temperature rises, the radiation emitted contain more and more of shorter wavelengths. In other words, as the temperature is raised, the maximum intensity of emission is displaced (shifted) towards the shorter wavelength side.

This is known as Wein's displacement law.

Deductions :→

Wein has also shown that the energy Emax is directly proportional to the fifth power of the absolute temp.

$$E \propto T^5$$

$$E_m = \text{Constant} \times T^5$$

$$\text{or} \quad E_m T^{-5} = \text{constant} \quad \text{---------- (2)}$$

These two relations ⊗. (1) and (2) can be combined into one and expressed as

$$c\lambda^{-5} f(\lambda T) \quad \text{---------- (3)}$$

Here c is constant and $f(\lambda T)$ is some function of λT.

To determine the form of $f(\lambda T)$, wein made some arbetrary but plausible assumptions concerning the actual mechanism of emission and absoption of radiation and concluded that the function should have the form $Ae^{-a/\lambda T}$

$$\therefore E_\lambda = c\lambda^{-5} A e^{-a/\lambda T} = K\lambda^{-5} e^{-a/\lambda T}$$

Here E_λ = Emissive power of the black body which has a max^m value at absolute temperature T

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Here K is another constant having value 4.94×10^{15} C.G.S unit and another constant has a value ~~1.43 degree~~ 1.43 cm degree.

Multiplying both side by $d\lambda$

$$E_\lambda d\lambda = K\lambda^{-5} e^{-a/\lambda T} d\lambda$$

Now $E_\lambda d\lambda$ represents the amount of energy dE associated with the spectral region lying ein the wavelength range λ and $\lambda + d\lambda$ emitted by a black body at temp T.

$$\therefore dE = K\lambda^{-5} e^{-a/\lambda T} d\lambda \quad \text{---} \quad (4)$$

This expression is known as Wein's law of energy distribution.

This law, however as found not to record with the experimental curves of Lummer and Pringsheem. The success of wein's law is that it holds good only in the region of shorter wavelength at lower at higher temperature.