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11. **Laws of Black body Radiation**

Rayleigh - Jeans law (classical physics)

Stefan Boltzmann law (

Wein's Displacement law

planck's Radiation Law (quantum physics)

Rayleigh - Jeans law

The energy distributions is directly proportional to the absolute temperature and is inversly proportional to fourth power of wavelength.

The Rayleigh - Jeans law is quite successful at long wavelengths. It fails badly at short wavelengths

The failure has become known as the ultraviolet catastrophe

In classical Theory, the energies of EM waves are continuous

$$I(\lambda, T) = \frac{2\pi c k T}{\lambda^4}$$

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Stefan Boltzmann law

The total amount of radiation emitted by a Blackbody is directly proportional to the fourth power of its absolute temperature.

The energy radiated by a Blackbody per second per unit area is directly proportional to the fourth power of its absolute temperature

$$Energy = \sigma T^4$$

Stefan-Boltzmann Law

This law links to

the total amount of energy flux that is emitted by a black body to the body's temperature (4^{th} power of body's absolute temperature)

Wein's Displacement Law

The intensity I is the total power radiated per unit area per unit wavelength at a given temperature

Wein's displacement law :- The maximum of the distribution shifts to smaller wavelengths as the temperature is increased

$$\lambda_{max} T = 2.898 \times 10^{-3} mk$$

wavelength decreases as T increases

This law holds good only for shorter wave-lengths and not for longer wavelengths

wein's law can be represented as:

$$\lambda_m = a/T$$

where λ_M is wavelength in the spectrum at which energy peak occurs

"The Hotter the body, the shorter the wavelength"

planck's Theory of Black body Radiation

→ In 1900 planck developed a theory of Black body radiation that leads to an equation for the intensity of the radiation

→ This equation is in complete argeement with experimental observations.

→ He assumed the cavity radiation came from atomic oscillations in the cavity walls.

→ planck made two assumptions about the nature of the oscillators in cavity walls.

planck's Assumption -1

The energy of an oscillator can have only certain discrete values E_n

$$E_n = nhf$$

This says energy is quantized

190031187

planck's Assumption-2

The oscillators emit or absorb energy when making a transition from one quantum state to another

planck generated a theoritical expression for the wavelength distribution

$$I = \frac{2\pi h c^2}{\lambda^5 \left(e^{hc/\lambda k_B T} - 1 \right)}$$

$$h = 6.626 \times 10^{-34} \ JS$$

At long wavelengths, planck's equation reduces to Rayleigh-Jeans expression

At short wavelengths it predicts an exponential decrease in intensity with decreasing wavelength

- This is in agreement with experimental results.