Quantum Mechanics

Here we will simply introduce the underlying ideas of quantum theory and the wave-particle nature of matter. First we shall discuss the requirement of quantum mechanics. In order to do that we shall first discuss with the phenomena of black body radiation and its characteristics.

Black Body Radiation Spectrum

A black body absorbs all radiations incident upon it. It behaves as a perfect radiator when it is heated.

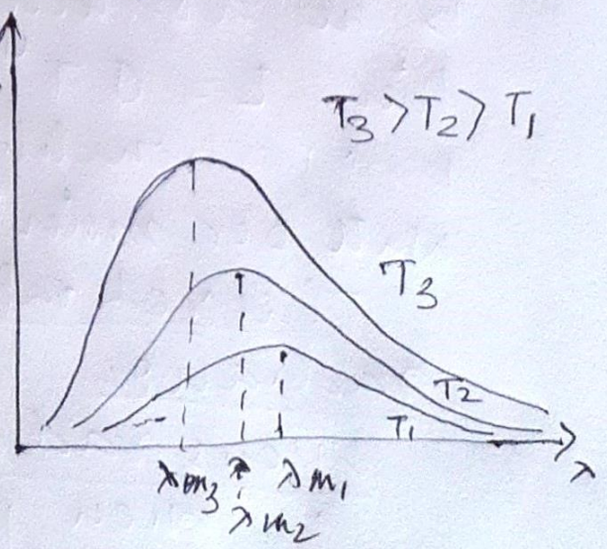
The radiation emitted by blackbody depends only on its temperature not on the nature of the material.

The experimetal spectrum of black body radiation are drawn between intensity and wavelength of black body radiation at different temperature as shown below

Experimental Observations

1. The increase in temperature results decrease in wavelength λ_m at which energy emitted is maximum.

$\lambda_m T = \text{Const} = 0.2896$ was given by Wein's and is known as Wien's displacement-law.



2. Intensity of radiation increases with increase of wavelength at particular temperature and

becomes maximum at a particular wavelength and then after intensity of radiation decreases with increase of wavelength.

3. In the radiation spectrum of a blackbody energy is not uniformly distributed.

4. Increase in temperature results an increase in energy emission for all wavelengths.

5. At a particular temperature for the range of wavelength considered, total energy emitted by the blackbody is represented by the area under each curve.

Stefan's Law

The total radiant heat energy emitted from a surface is proportional to the fourth power of its absolute temp. If E is the radiant heat energy emitted from unit area in one second and T is the absolute temperature in ~~Kelvin~~ Kelvin then $E = \sigma T^4$, where σ is constant of proportionality and has the value 5.67×10^{-8} watt per meter^2 per K^4

Theoretical explanation of blackbody radiation

Wien's radiation law

W. Wien proposed an empirical relationship between E_λ and λ for a temp T of blackbody $E_\lambda(T)\, d\lambda = \frac{c_1}{\lambda^5} f(\lambda T)\, d\lambda$, c_1 is const. and $f(\lambda T)$ is a function of product λT.