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Quantum THEORY

Black body radiations: Black body is one, when incident beam of light having large wavelengths falls on (body) it, then it absorb radiation of light of all wavelength

When such body is heated then it will emit the radiations of all wavelength and these radiations at ordinary temperature is called black body radiations.

Planck's Radiation law:

Planck's successfully gives the theoritical explanation of energy distribution of black body on the basis of quantum theory of heat radiations.

Acc. to planck's hypothesis, Black body contains a simple harmonic oscillator that vibrates at / with all possible frequency. The oscillators of frequency ν exchange energy with surrounding in discrete units called photon. Energy of photon is hν.

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$$E_\lambda d\lambda = \frac{8\pi hc}{\lambda^5} \frac{1}{e^{hc/\lambda kT} - 1} d\lambda$$

or $E_\lambda d\lambda = \frac{8\pi kT}{\lambda^4}$

(Rayleigh - Jeans law)

Energy of photon: Energy of photon is whole number multiple of $h\nu$ where h is planck's constant and ν is frequency. Acc. to modern ideas, energy of photon is limited by $\frac{1}{2} h\nu$.

Constant h: Constant h is responsible for discreteness of photon, making a radiation to behave like particle.

The dimensions of $h = \frac{E}{\nu} = \frac{ML^2T^{-2}}{T^-}$

$= ML^2T^-$

Photoelectric effect:
It is the phenomenon of ejection of electron from the metal surface when the incident beam of light of suitable wavelength is incident on the metal surface. The emitted electron are called photoelectrons.

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Laws: 1) The number of emitted electron is directly proportional to intensity of incident beam of light.

2). The velocity of emitted electron increases with increase in the frequency of incident beam.

3). A light of frequency less than ν_0 is unable to eject e^- from the metal surface. This is called threshold frequency.

When electromagnetic radiation of wavelength λ having energy $h\nu$ falls on metal surface then energy is used up:

1). in ejecting the electrons from metal surface known as work function ϕ_0

2). Rest energy imparts to the K.E of the electron.

$$h\nu = \phi_0 + \frac{1}{2}mv^2$$

Notes

$$h\nu - h\nu_0 = \frac{1}{2}mv^2$$

$$h(\nu - \nu_0) = \frac{1}{2}mv^2$$

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Compton Effect: When high frequency radiation is scattered by the electron of the scatterer, then frequency of scattered wave is less than frequency of incident wave or wavelength of scattered radiation is greater than radiation of incident radiation.

Limitations of Quantum theory:

1) It is not applicable to nonperiodic systems.
2) It couldn't explain the dispersion of light.
3) It couldn't explain the spectral lines of system like H_2 molecule and normal helium atom.
4) It couldn't explain the process connected with electron spin and pauli exclusion principle.

Acc. to De broglie hypothesis, particle in motion having a wave whose wavelength is $\lambda = \frac{h}{p}$

where $p = mv$ - momentum

Notes

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8.00 Group Velocity is defined as the

9.00 Velocity at which Slowly varying packet travels in a medium due

10.00 to group of waves.

$$v_g = \frac{dw}{dk} = v \text{ (particle velocity)}$$

11.00 w - angular frequency

12.00 k - wave number

1.00 Wave packet: Wave packet is the type of wave motion of group of

2.00 waves each having different velocity and wavelength, (with)

3.00 (comprising phase and amplitude in such a way that they can

4.00 interfere in small space region where particle is located and

5.00 outside of which they can form destructive interference so that

6.00 amplitude is reduced to zero value.

7.00 Phase Velocity $V_p = \frac{dw}{dk} = \frac{w}{k}$

8.00

Notes

$V_g = \frac{1}{2} V_p$

(group velocity) (phase)

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8.00 **Uncertainity principle:** It States that it is imposible to find out position of particle along a direction and momentum of particle in Some direction with unlimited accuracy.

$$\Delta x \, \Delta m_x = h \quad \text{(position–momentum)}$$

$$\Delta E \, \Delta t \cong \hbar \quad \text{(Energy time)}$$

Application:

1). Non existence of electron in the nucleus.
2). Existence of proton, nuetron and alpha particles in the nucleus.
3). Determination of Size of atom.

Schrödinger Equation:

$$i\hbar \frac{d\psi}{dt} = -\frac{\hbar^2}{2m} \frac{d^2\psi}{dx^2} \quad \text{(time independent)}$$

Notes

$$i\hbar \frac{d\psi}{dt} = -\frac{\hbar^2}{2m} \frac{d^2\psi}{dx^2} + V(x,t)\,\psi$$

(time dependent)

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$$\frac{d^2\psi}{dx^2} + \frac{2m}{h^2}[E - V(x)]\psi(x) = 0$$

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Significance of ψ: wave function ψ is the general solution of Schrodinger equation and assumed to provide information about the behaviour of particle.

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ψ may be regarded as measure of probability of finding a electron about particular position.

11.00

$|\psi(x,t)|^2$ is called position probality density.

12.00

$\int |\psi(x,t)|^2 dx$ is probality that the particle will found at small distance dx in time t at position x.

1.00

Fermi Dirac: Applies to all the indistinguishable particle which obey pauli exclusion principle.

2.00

Acc. to this principle, not more than one particle can occupy a given cell. These particles are fermions.

3.00

$$\frac{N_i}{g_i} = \frac{1}{1 + e^{\alpha + \beta E_i}}$$

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Notes

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Bose Einstein: It is applicable to

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indistinguishable particle that have spin angular momentum. In this any no of particle can occupy

10.00

given cell. These particles are called Bosons.

11.00

$$\frac{N_i}{g_i} = \frac{1}{-1 + e^{\alpha + \beta i}}$$

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