Introduction to Quantum Physics

Blackbody Radiation

Any object at any temperature emits radiation.

→ Hypothetical object

Does not exist

Perfect absorber & emitter of radiation

Nothing is lost in the blackbody (wrt radiation)

Stefen's Law

$$P = \sigma A e T^4$$

T → Temperature of object (K)

e → emissivity of surface (for blackbody, $e = 1$)

P → Power (W)

σ → constant

A → Surface Area of Object

Wien's Law

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

when $T \uparrow$ $\lambda_{max} \downarrow$

$T \uparrow$ Intensity $\uparrow$

$T \uparrow$ Power $\uparrow$

Rayleigh-Jeans Law

$$I = \frac{2\pi c k_B T}{\lambda^4}$$

c → speed of light

I → power per unit area

T → temperature

I → Intensity

λ → wavelength

Accurate only for large wavelengths

Example

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

$$\lambda_{max} = \frac{2.898 \times 10^{-3}}{308} \text{ m}$$

$$= \underline{9.41 \ \mu m}$$

Planck's constant

$E_n = nhf$ → frequency

h → Planck's constant

n → +ve integer, quantum number

E_n → Energy

→ Energy is Quantized

E_n will always be a whole number multiple of hf

Planck's Wavelength Distribution function

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

$$h = 6.626 \times 10^{-34} \text{ J/s}$$

Photoelectric Effect

When light is incident on certain metallic surfaces, electrons are emitted from these surfaces.

$$K_{max} = e\Delta V_s$$

K_{max} → Max Kinetic Energy

Charge of electron

Stopping potential
↓
Voltage required to be applied across the metallic surface to stop the electron from moving to the other end of the surface.

Each metal has its own ΔV_s.

$f_c \rightarrow$ Critical frequency

Minimum frequency required to emit electrons.

Higher the frequency of the light wave increases maximum kinetic energy of the emitted electron.

$K_{max} = hf - \varphi$

K_{max} → Max Kinetic Energy

h → Planck's Constant

f → Frequency

φ → Work Function (eV) → Min energy required to free the electron from its atom.

Cut off Frequency

$$\lambda_c = \frac{c}{f_c} = \frac{hc}{\varphi}$$

c → Speed of light

λ_c → cut off wavelength

f_c → cut off frequency

Compton Effect

different frequency and

Compton Effect

$$\lambda' - \lambda_0 = \frac{h}{m_e c}(1 - \cos\theta)$$

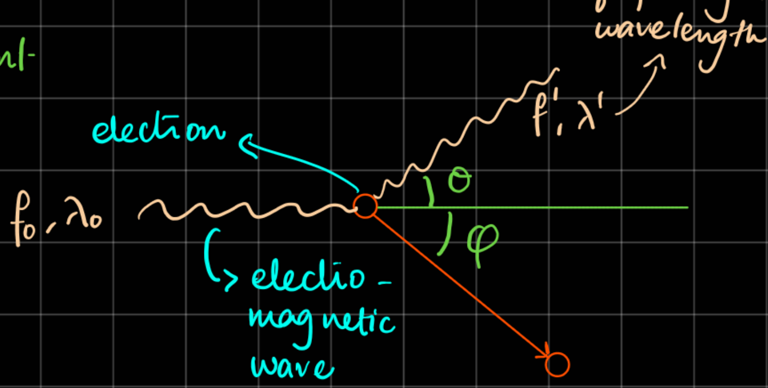
h → Planck's Constant

c → Speed of light

m_e → mass of electron

λ_0 → striking wavelength

λ' → new wavelength



Wave Properties of Particles

$$\lambda = \frac{h}{p} = \frac{h}{mu}$$

p → momentum