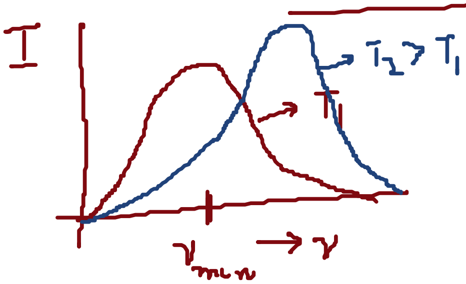
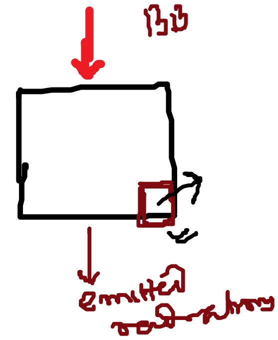
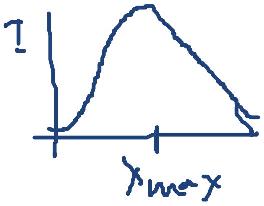
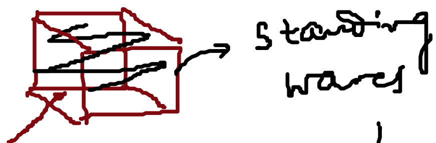
Failure of Classical Theory :-



$$\boxed{\lambda_{max} T = b}$$ Wien's Law



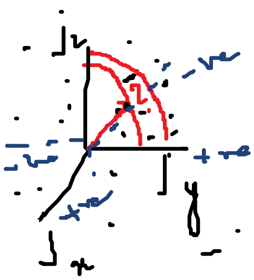


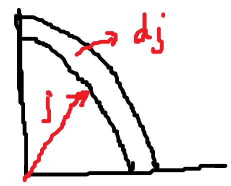


$$j_{x,y,z} = \frac{2L}{\lambda}, \quad j_x = 1, 2, 3 \ldots$$

$$\lambda_j \rightarrow \nu_j$$

No. of standing waves present in the interval ν & $\nu + d\nu$





$$g(\nu)d\nu = (2) \cdot \frac{1}{8} \cdot 4\pi j^2 \, dj = \pi j^2 dj$$

$$\boxed{\begin{matrix} U & K.E, P.E \\ \bar{E} = KT & \end{matrix}}$$

$\boxed{j_x, j_y, j_z} \neq 0$

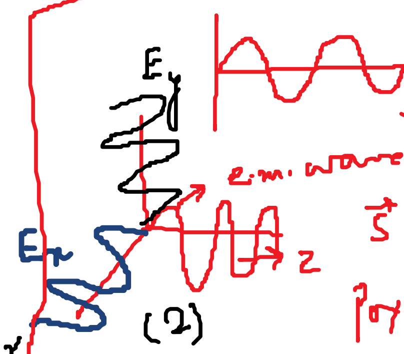
$j_x = 1, 2, 3 \ldots$

$$j^2 = j_x^2 + j_y^2 + j_z^2 = \left(\frac{2L}{\lambda}\right)^2$$

$$j = \frac{2L}{\lambda} = \frac{2L\nu}{c}$$

$$dj = \frac{2L}{c} \cdot d\nu$$

$$g(\nu)d\nu = \pi \cdot \frac{4L^2\nu^2}{c^2} \cdot \frac{2L}{c} d\nu$$



$$\vec{S} = \frac{1}{\mu_0} \vec{E} \times \vec{B}$$

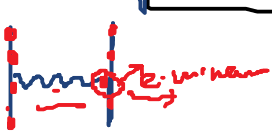
Poynting vector

$$\text{No. of standing wave} = G(\nu)d\nu = \frac{8\pi L^3}{c^3} \cdot \nu^2 d\nu$$

I = Energy density

$$\boxed{\text{Density of standing wave} = \frac{8\pi \nu^2 d\nu}{c^3} \cancel{\nu} \times K_B T}$$

Rayleigh-Jeans



Classical Thermodynamics $\bar{E} = K_B T$

$$U \begin{cases} K.E \\ P.E \end{cases}$$

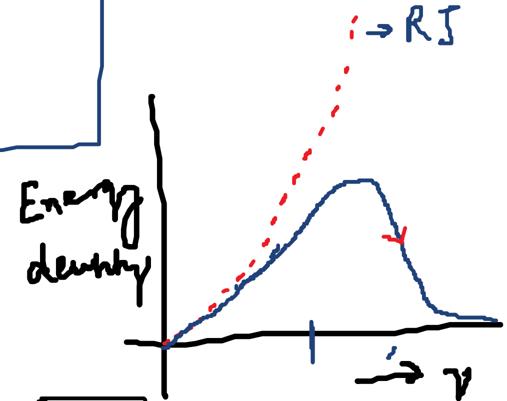
-24 th

Classical Thermodynamics (T) $\bar{E} = K_B T$ 1·E

K_B = Boltzmann Con $= 1.38\times10^{-24}$ J/K

Rayleigh Jeans Formula →

$$\boxed{u(\nu)\,d\nu = \frac{8\pi\nu^2}{c^3} K_B T \, d\nu}$$



Ultraviolet catastrophe

Planck's Radiation Formula → $\left\{ \bar{E} = \frac{h\nu}{e^{h\nu/KT}-1} \right\}$ $E \begin{cases} MB \\ BE \\ FD \end{cases}$

$$\boxed{u(\nu)\,d\nu = \frac{8\pi\nu^2}{c^3}\cdot\frac{h\nu}{e^{h\nu/KT}-1}\cdot d\nu}$$

→ ν small RJ
ν large exp.

1. $h\nu >> KT$, $e^{h\nu/KT} \to$ Large magnitude ∞, $\left(\frac{\nu^3\, d\nu}{e^{h\nu/KT}-1}\right) \to 0$

2. $h\nu << KT$, $\frac{h\nu}{KT} << 1$ $(0.01)^2$ 10^{-6}

$$e^{h\nu/KT} = e^x = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \dots \simeq 1 + x = 1 + \frac{h\nu}{KT}$$

$x = \frac{h\nu}{KT}$

$$e^{h\nu/KT} - 1 = x = \frac{h\nu}{KT}$$

ν small $\quad u(\nu)\,d\nu = \frac{8\pi\nu^2}{c^3}\cdot\frac{h\nu}{h\nu/kT}\,.d\nu = RJ.$

Blackbody radiation : $\boxed{E \propto h\nu}$

Particle nature of wave :→

Photoelectric experiment

0.1 - 1 MeV

Compton experiment

0.1 - 10 MeV

Pair production

Pair

$\gamma \rightarrow e^+ + e^-$

> 10 MeV

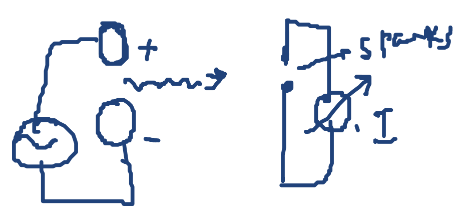
- 100

Photoelectric Effect :→

Hertz : E.M wave

$\tilde{E}(t)$

Photons wave



Leonard

$I = 0$

↑

eV_{max}

$\boxed{E = h\nu}$

$h\nu = K.E + \phi$

- Instantaneous generate current
- $I \uparrow$, No change in

- $I \uparrow$, No change in Stopping potent
- $\nu \uparrow$, change in Stopping potential

$$h\nu = K.E + \phi$$

$$eV_{max} = K.E = h(\nu - \nu_0)$$

$$eV, \quad E = h\nu, \quad h = 6.6 \times 10^{-34}\ J.s$$

$$= \left(\frac{6.6 \times 10^{-34}\ J.s}{1.6 \times 10^{-19}\ \frac{J}{eV}}\right)\nu \simeq 4.3 \times 10^{-15} (eV\ s)\ \nu$$

$$= \frac{4.3 \times 10^{-15}\ eV.s \times c}{\lambda} \quad 3\times10^{8}\ m/s$$

$$\boxed{E \simeq \frac{1.2 \times 10^{-6}\ eV.m}{\lambda}}$$

② Compton Effect :-

Scattering Collision

$$\nu' - \nu \rightarrow (\lambda' - \lambda)$$

$$\boxed{\Delta\lambda \rightarrow \left(\frac{h}{mc}\right)(1 - \cos\phi)}$$

λ_c