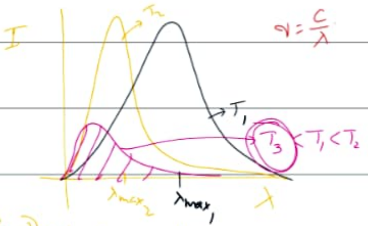
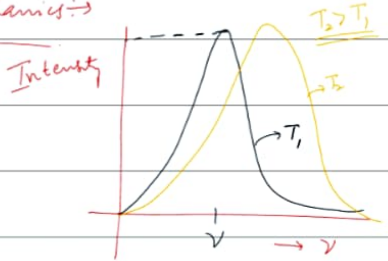
01/11/2023

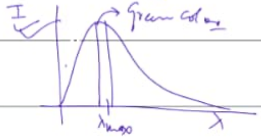
Failures of Classical Mechanics:→



$\nu = \frac{c}{\lambda}$



Wien's Displacement



$\lambda_{max} T = 2898 \times 10^{-3}\, mK$,

Stefan Boltzmann Law

$R(T) = \epsilon \alpha T^4$

$\lambda_{max}\, 6000K = 2898 \times 10^{-3}\, mK$

$\lambda_{max} \simeq 480 \times 10^{-9}\, m$

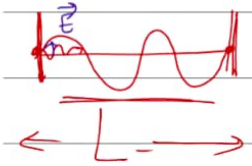
=

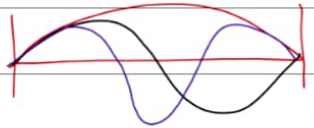
Rayleigh-Jeans Law:

$\frac{c}{\lambda_n} = \lambda_n = \frac{2L}{j}$

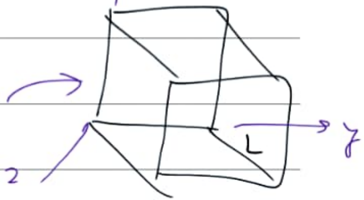
$\epsilon = 1$

L^3





$\sqrt{j_x^2 + j_y^2 + j_z^2}$



1 mode $\frac{\lambda}{2} = L$

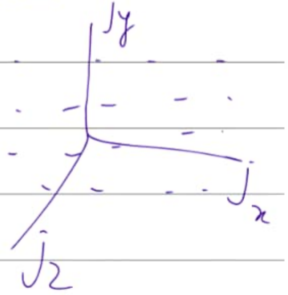
$\Rightarrow \boxed{j_x \lambda = 2L}$, $j = 1, 2, 3, \ldots$

$\lambda = L$

$\frac{3}{2}\lambda = L$

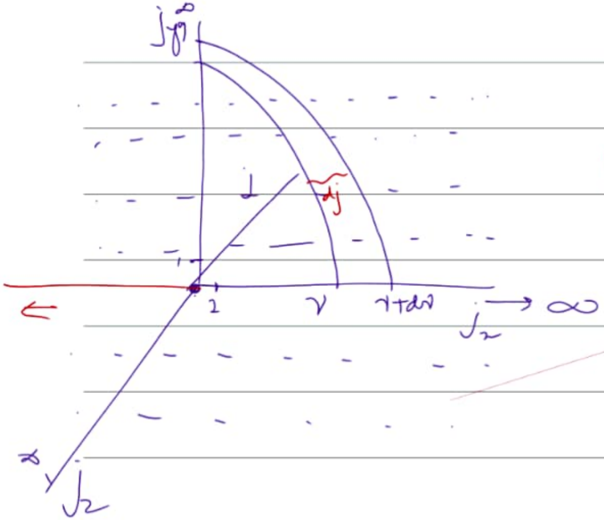
$j_y \lambda = 2L$

$j_z \lambda = 2L$



For any arbitrary Direction, Standing wave $= \sqrt{j_x^2 + j_y^2 + j_z^2}$

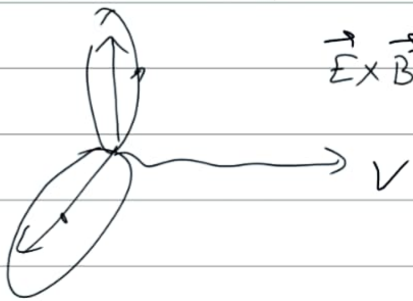
$$j_x = \frac{2L}{\lambda}, \; j_y = \frac{2L}{\lambda}, \; j_z = \frac{2L}{\lambda}$$



Vollume of Standing (No. of Standing) Wave

$$= \underline{4\pi j^2 \, dj \times \frac{1}{8}} \times 2 = \pi j^2 \, dj$$

$g(\nu)d\nu$



$\vec{E} \times \vec{B} =$

$$g(\nu)\,d\nu = \pi j^2\, dj$$

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

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

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

$$g(\nu)\,d\nu = \frac{8\pi \cancel{L^3}}{c^3 \cancel{L^3}}\, \nu^2\, d\nu = \frac{8\pi}{c^3}\nu^2\, d\nu = \text{Density of standing wave formed in the cavity.}$$

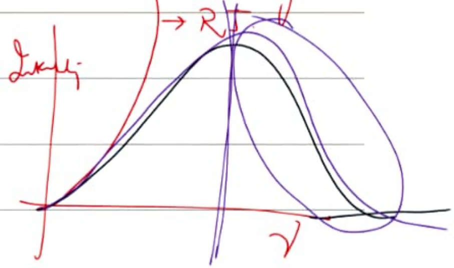
$\dfrac{\text{No. of standing wave.}}{\text{Volume}}$

$$\frac{h\nu}{e^{h\nu/kT}-1} = \bar{\epsilon} = K_B T$$

$\left(\begin{array}{l} 1/2 \cdot 1 \text{ degree} \\ 3/2 \;\; 3 \text{ degree} \end{array}\right)$

R.J. Radiation Law.

$$\text{Intensity} = \frac{8\pi\nu^2\, d\nu}{c^3} \cdot K_B T$$



Planck's Radiation Law:-

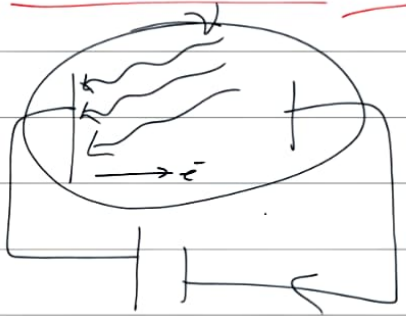
$$I = \left(\frac{8\pi\nu^2 d\nu}{c^3}\right) \cdot \frac{\cancel{h\nu}}{e^{h\nu/KT} - 1} \quad \frac{\cancel{h\nu}}{KT}$$

① For large ν. $\frac{h\nu}{KT} >> 1$, $h\nu >> KT$, $e^{h\nu/KT} \to \infty$

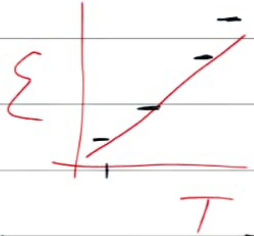
② For small ν, $\frac{h\nu}{KT} << 1$, $h\nu << KT$, $e^{h\nu/KT} \approx 1 + \frac{h\nu}{KT}$

$e^x = 1 + x + \frac{x^2}{2!} + \ldots$ $\quad e^{h\nu/KT} - 1 \approx \frac{h\nu}{KT}$, $I =$

Photoelectric Effect:



$\mathcal{E} = K_B T$

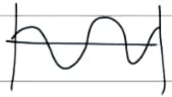


$\to \nu$

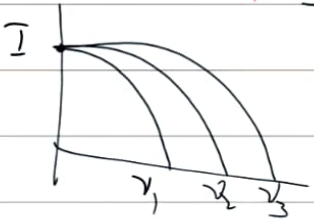
$\boxed{\mathcal{E} = nh\nu}$

$\mathcal{E}_1 = h\nu$

$\mathcal{E}_2 = 2h\nu$



$$eV_{max} = h\nu_0 + h\nu$$



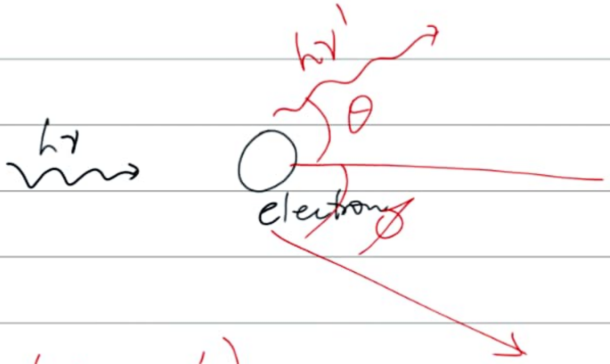
$E = \frac{1}{2}KA^2$

② Compton Effect :→

Planck's

$E = nh\nu$

$$p = \frac{E}{c} = \frac{h\nu}{c}$$



$h(\nu - \nu') \rightarrow$ Quantized

$$\frac{h}{mc}\left[1 - \cos\theta\right]$$