

Date  
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SEM-VI paper-II Unit-03.

Derivation Outline of Planck's Law.

- Step ① :- No of Modes in Cavity :-  $\infty$   
 From Electromagnetic theory :-  
 Number of standing waves between  $\nu$  and  $\nu + d\nu$ .

$$\left[ \frac{8\pi\nu^2}{c^3} d\nu \right] \text{ This is density of states.}$$

- Step ② :- Average Energy of Oscillator.  
 Using Boltzmann Statistics :-  
 Probs probability :-

$$P_n = e^{-E_n/KT}$$

Average energy:

$$\bar{E} = \frac{\sum E_n e^{-E_n/KT}}{\sum e^{-E_n/KT}}$$

Substituting  $[E_n = nh\nu]$ 

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

- Step ③ Multiply Modes  $\times$  Average Energy

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

$$\text{So } \left[ u(\nu) = \frac{8\pi h\nu^3}{c^3} \cdot \frac{1}{e^{h\nu/KT} - 1} \right]$$

This is Planck's Radiation Law.