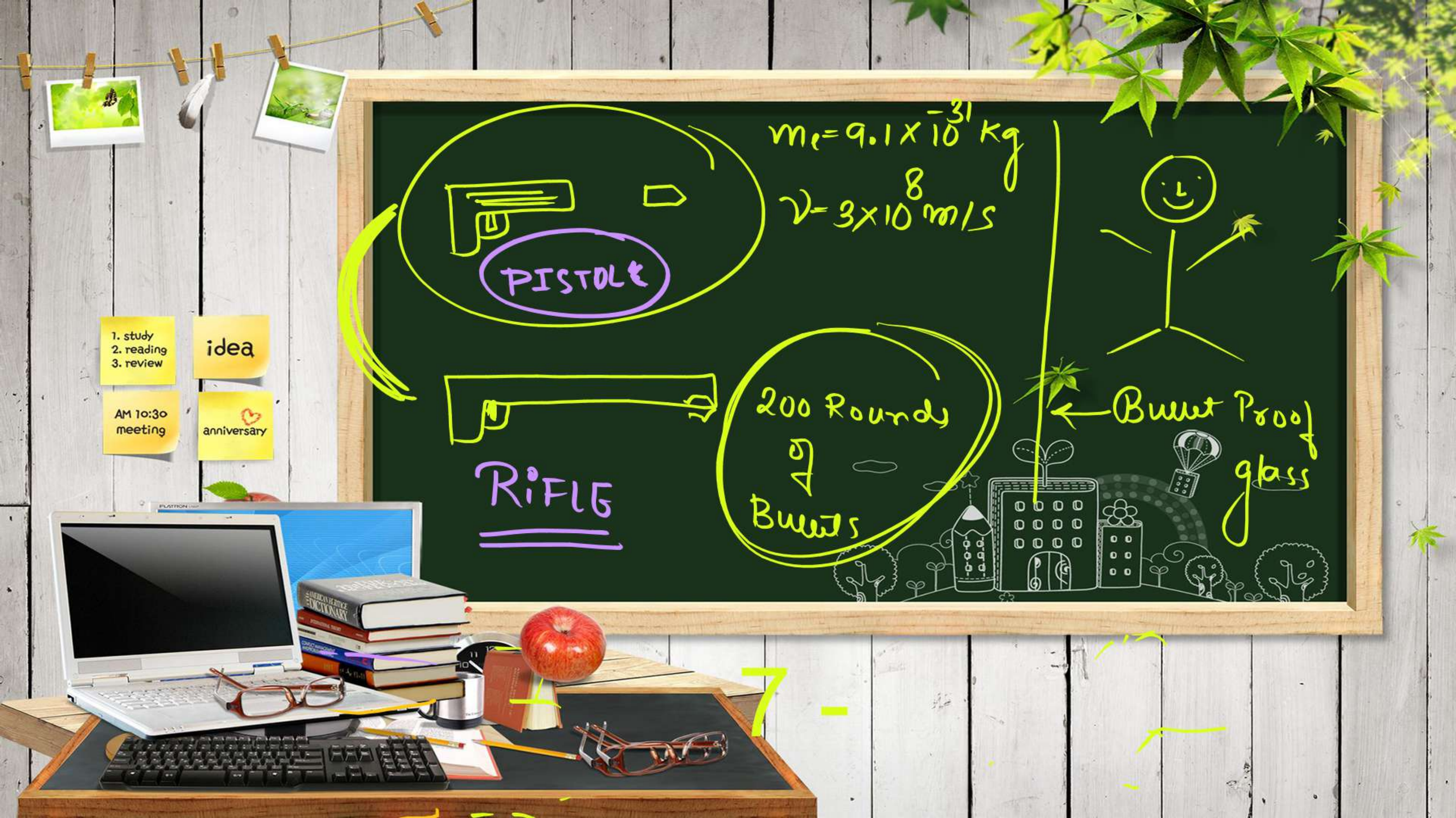
ARJUNA NEET BATCH

Structure of Atom

LECTURE - 4

BY : DOLLY SHARMA


PISTOL
RIFLE
$m_e = 9.1 \times 10^{-31}$ kg
$v = 3 \times 10^{8}$ m/s
200 Rounds of Bullets
Bullet Proof glass
1. study
2. reading
3. review
idea
AM 10:30 meeting
anniversary
7 -


1. study
2. reading
3. review
idea
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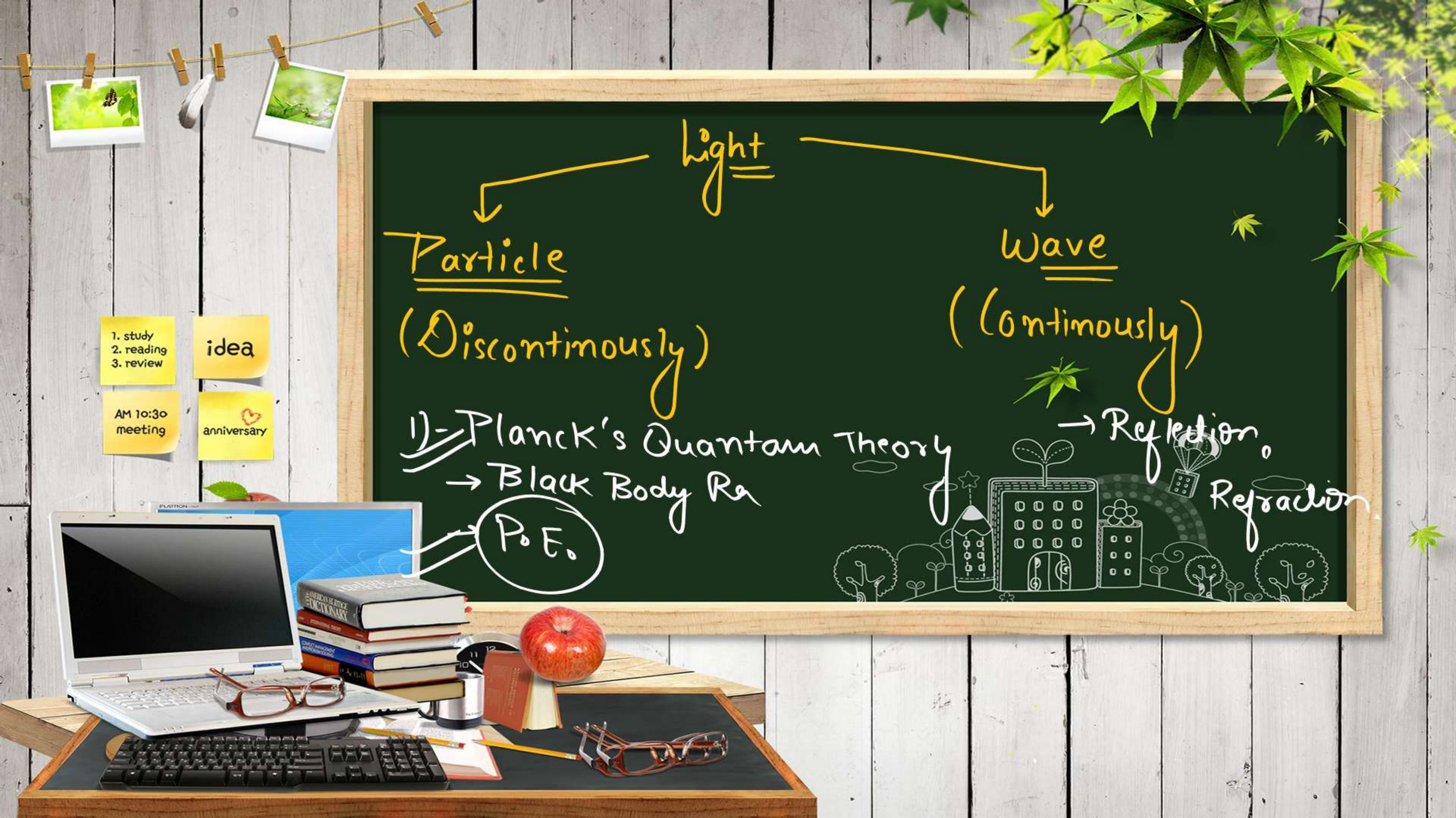
Light
Particle
(Discontinously)
Wave
((ontinously)
1)- Planck's Quantam Theory
→ Black Body Ra
P.E.
→ Reflection,
Refraction.
1. study
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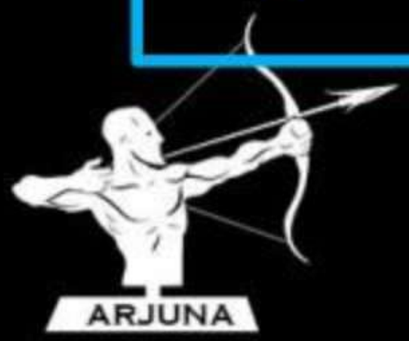
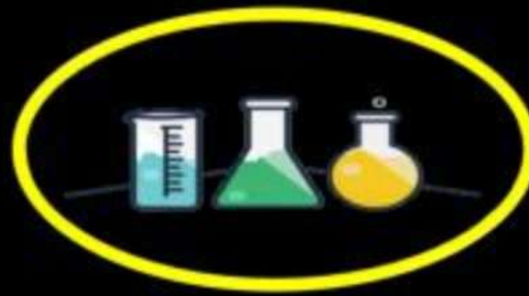
Objective of today's class

NATURE OF LIGHT ,ELECTROMAGNETIC RADIATIONS PLANCKS QUANTAM THEORY



NEWTON

- Light → Particle nature (Corpuscular Theory).
- Explained reflection , Refraction.
- Could not explain diffraction, interference.



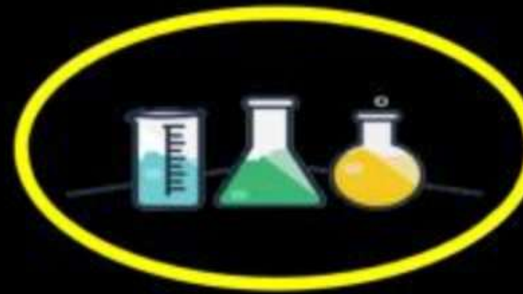
HUYGENS, CLARK MAXWELL

- Theory of EMW; Light = Wave Nature
- Explained Reflection , Refraction, Diffraction and Interference.
- Could not explain.
  - Photoelectric effect
  - Compton effect
  - Black body radiation
  - Variation of specific heat with T
  - Discontinuous spectra

PARTICLE NATURE

Physics.

EMW ⇒ Electromagnetic Waves



Wrong Assumptions :-

- Energy of wave (Light) α intensity of light α (Amplitude)^2
- Energy of wave (Light) , independent of frequency.

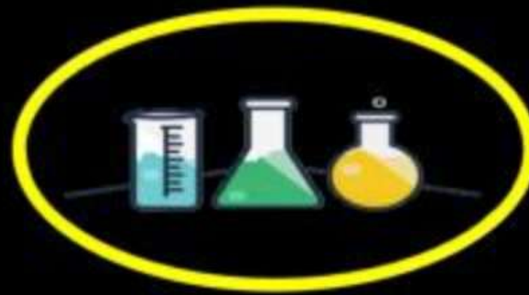
PLANCK

Light – Particle Nature

T.o.E., Black body Radiation

⇒ Explained – (i) , (ii) , (iii), (iv), (v)

⇒ Could not explain Reflection , Refraction (E = hv) represent dual nature.



EINSTEIN

Light = Dual nature

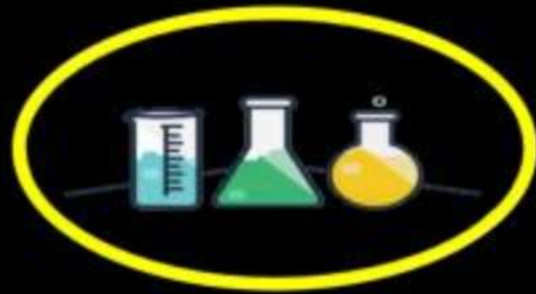
- Acc. to dual nature light propagate as wave & interact with matter as particle & interact with wave as wave.
- Wave Nature = Reflection, Refraction , Diffraction, Interference.
- Particle Nature – Black body radiation, Photoelectric effect.

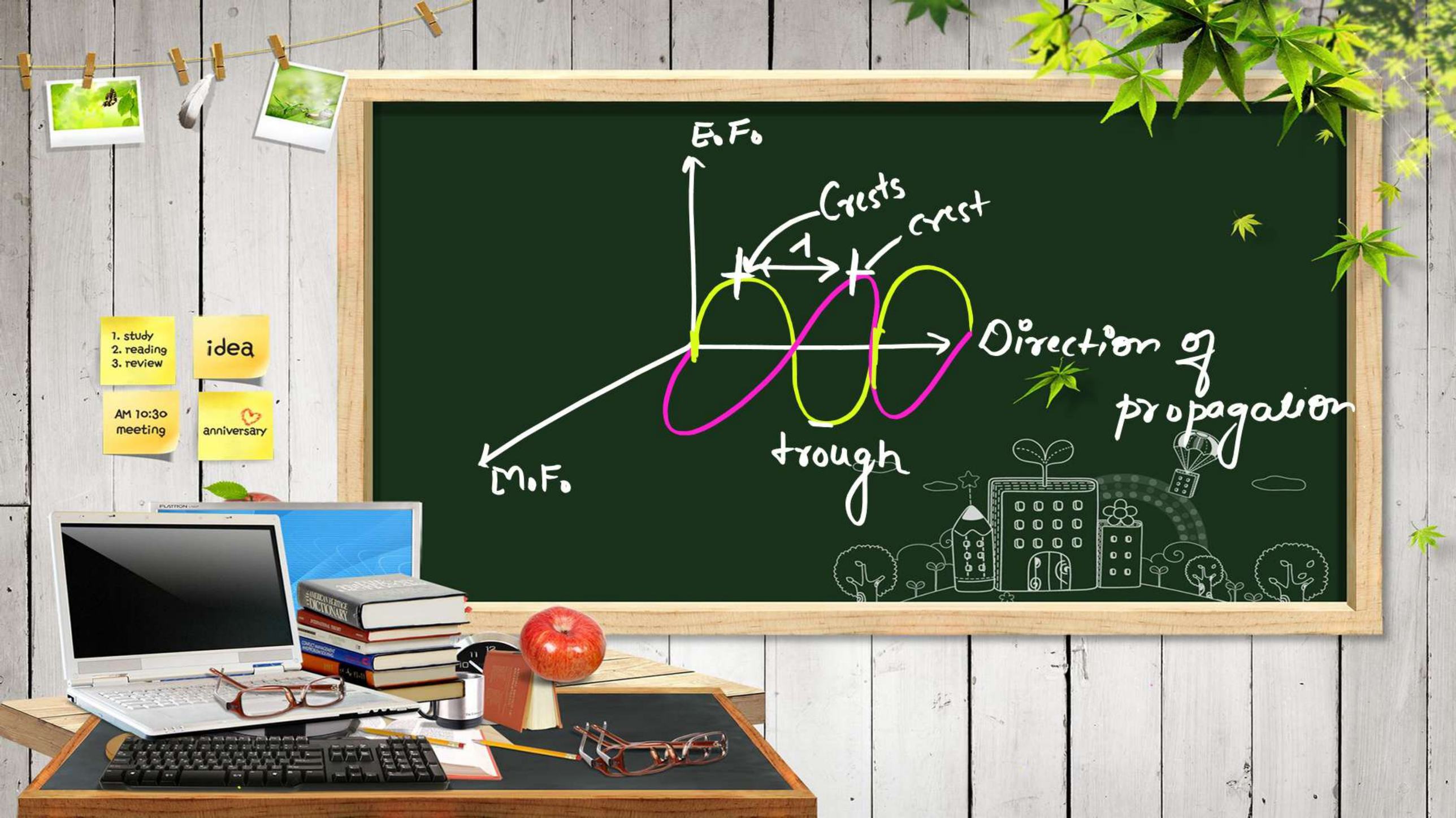
Electromagnetic waves/ Radiations (EMW):-

- EM Radiation are those which are associated with of EF & M.F. , perpendicula to each other as well as path of propagation.
- These radiations do not require any medium for propagation.
- They can not be deflected by External M.F. or E.F.
- They always travel with same speed i.e., 3×10^8 m/s = 3×10^{17} nm/s

EF → Electric Field

M.F. → Magnetic field




E.F.
Crests
crest
1
Direction of propagation
trough
M.F.
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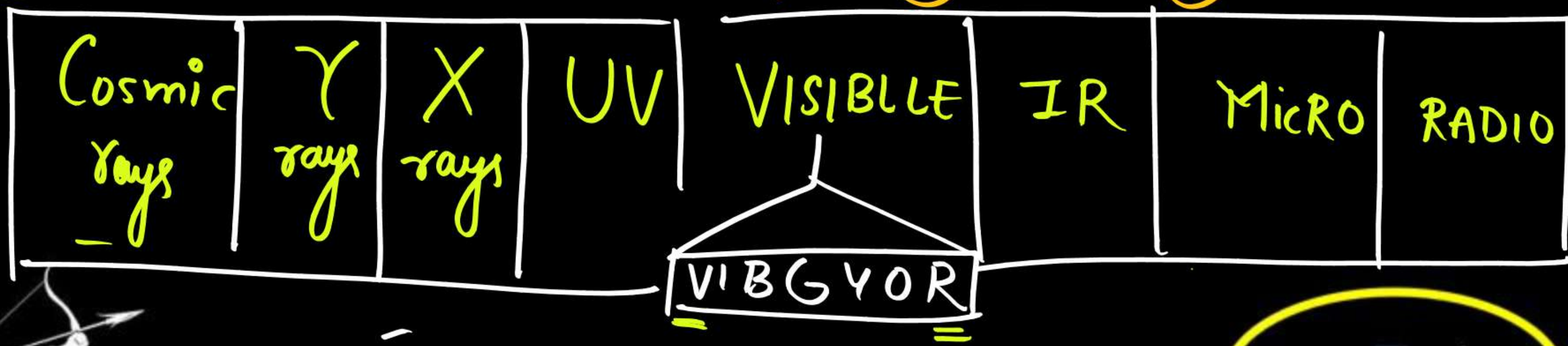
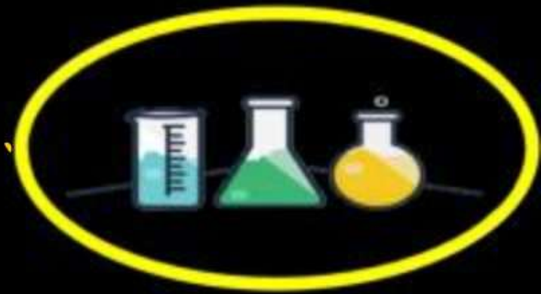
λ → Wavelength
→ frequency

- They leave their source behind.
- Arrangement of different EM radiation in increasing order of λ (wavelength) or decreases order of ν (frequency) is known as ELECTROMAGNETIC SPECTUM.





WAVELENGTH :- (1)

The distance between two consecutive crest & trough is known as wavelength. (1)

Wavelength is represented as nm, $\mathring{A}$, pm, fm.

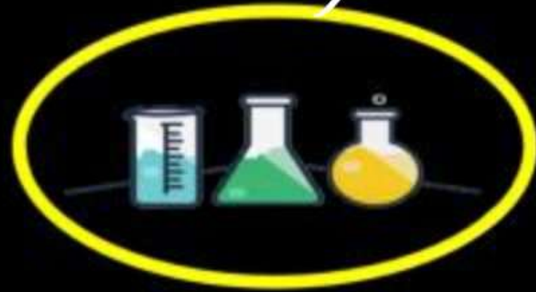
Units

$1\ pm = 10^{-12}\ m$

$1\ \mathring{A} = 10^{-10}\ m$

$1\ fm = 10^{-15}\ m$

$1\ nm = 10^{-9}\ m$



FREQUENCY (ν) :-

ν

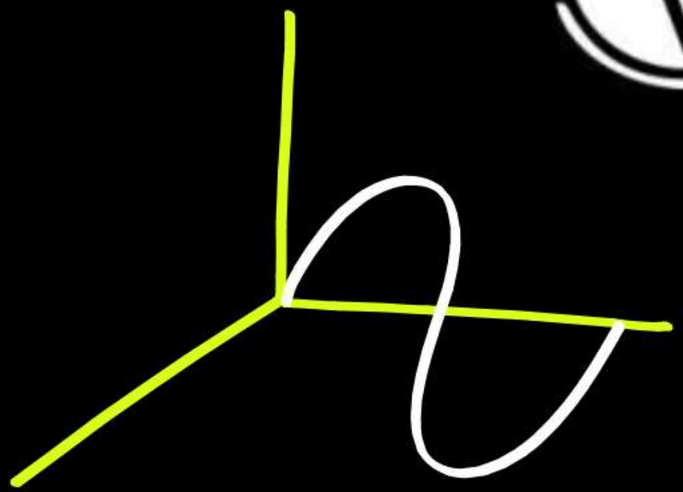
No. of Oscillation per second.

$v = c/\lambda$ (where c = velocity of light)

Unit = ~~Hertz~~, s^{-1}, Hertz

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

$$\nu = \frac{1}{T}$$



$T \Rightarrow$ Time period

ARJUN

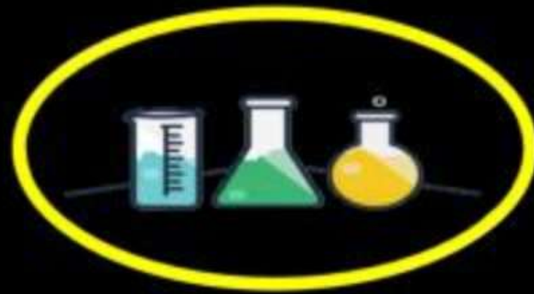
WAVE NUMER:- ($\bar{\nu}$)

Reciprocal of wavelength

$\bar{\nu} = \frac{1}{\lambda}$ unit → m^{-1}

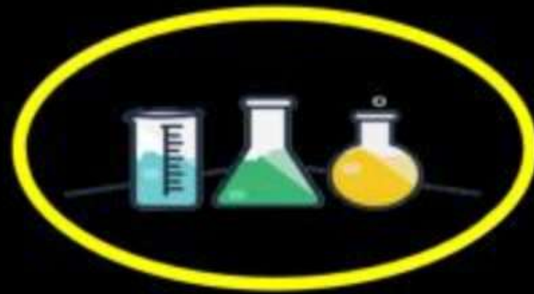
① $\nu = \frac{c}{\lambda}$ or $\nu = \frac{1}{T}$

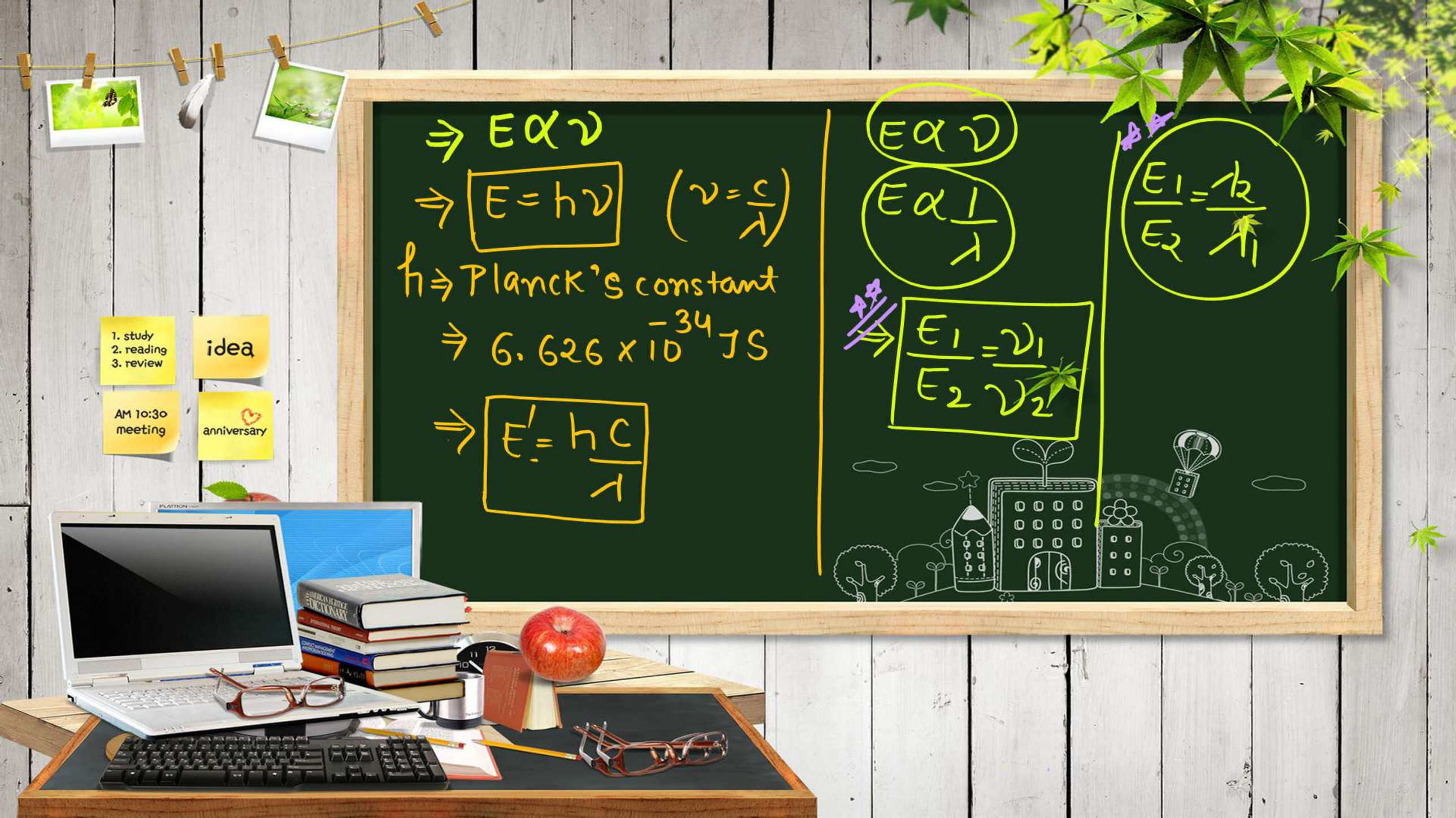
② $\bar{\nu} = \frac{1}{\lambda}$



PLANCK'S QUANTAM THEORY

- Energy is absorbed or emitted , not continuously, but discontinuously in form of small energy packets known as QUANTA
- In case of light they are known as PHOTONS.
- In case of heat they are known as PHONONS.
- Energy of each photon is directly proportional to its frequency (ν).




⇒ E α ν
⇒ E = hν (ν = c/λ)
h ⇒ Planck's constant
⇒ 6.626 × 10^-34 JS
⇒ E = hc/λ
E α ν
E α 1/λ
E1/E2 = ν1/ν2
E1/E2 = λ2/λ1
1. study
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$E \propto \nu \propto \frac{1}{\lambda}$; $\frac{E_2}{E_1} = \frac{\nu_2}{\nu_1} = \frac{\lambda_1}{\lambda_2}$

$\nu = \frac{c}{\lambda}$, $\bar{\nu} = \frac{1}{\lambda}$

- Energy of each photon $E = h\nu = hc/\lambda = hc\bar{\nu}$
- Total energy of 'n' photons $E = nh\nu = \frac{nhc}{\lambda} = nhc\bar{\nu}$
- Energy of one mole of photon = 1 Einstein energy $n = N_A$
- Power = $\frac{E}{t} = \frac{n}{t}\frac{hc}{\lambda}$

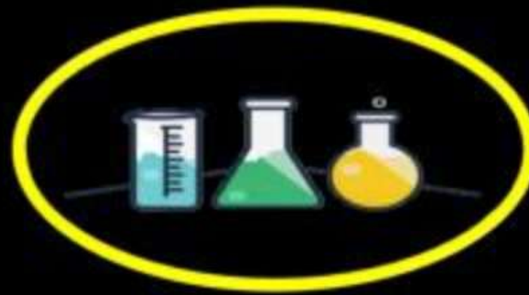
$E = nh\nu$ (n = no. of Photons)

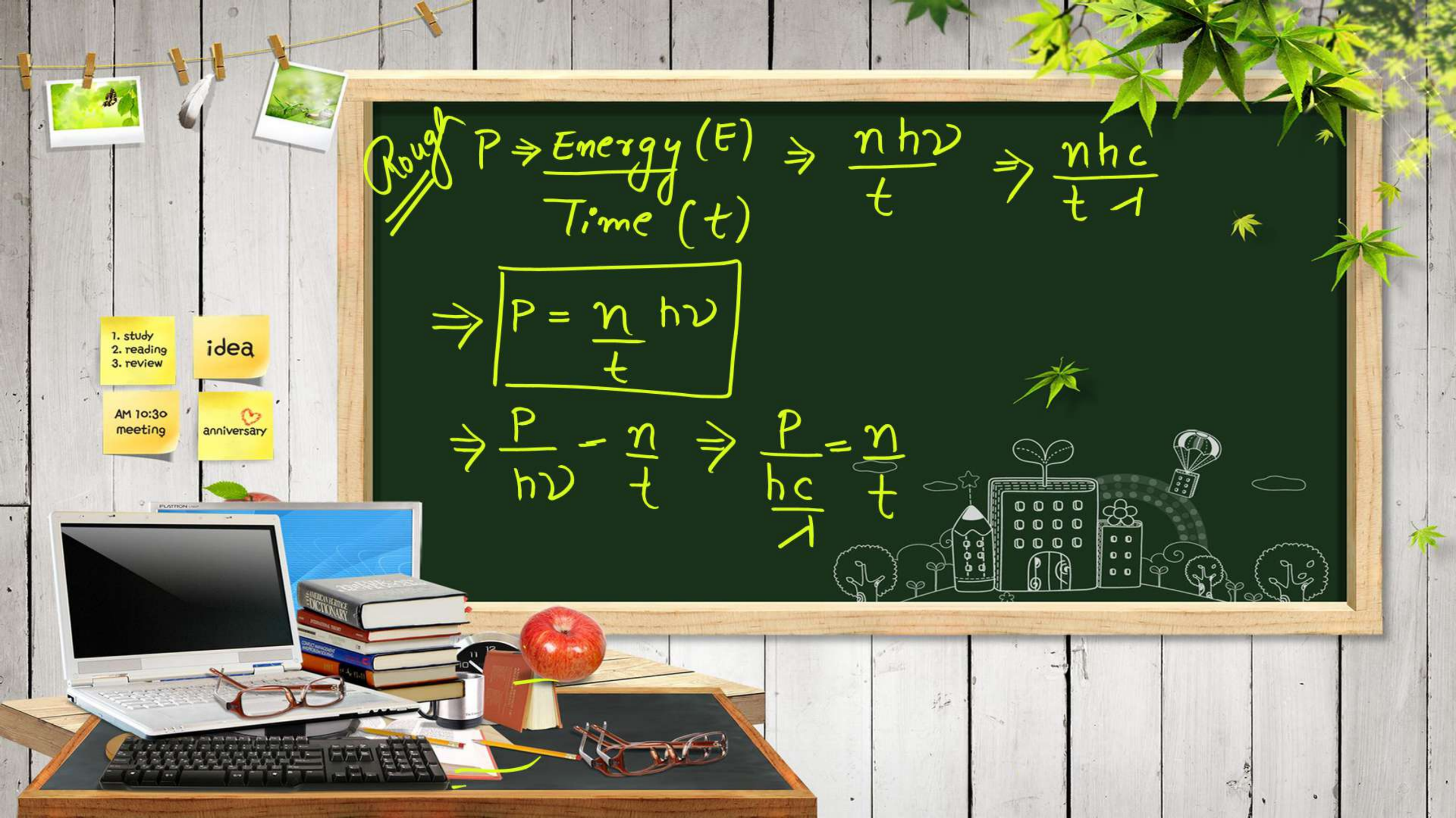
$\Rightarrow$ n/t = no. of photons per second

$\Rightarrow \frac{n}{t} = \frac{P}{\frac{hc}{\lambda}}$

[P = amount of Energy per unit time]

$h\nu/\lambda$ = Energy of 1 photon.




Rough
P ⇒ Energy (E) / Time (t) ⇒ nhν / t ⇒ nhc / tλ
⇒ P = n/t hν
⇒ P/hν = n/t ⇒ P/hc/λ = n/t
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h = Plank's contant = 6.626×10^{-34} JS

C = 3×10^{8} m/s

If λ = m hc = 2×10^{-25} J (If energy is in Joule)

If $\lambda = \overset{o}{A}$ hc = 12400 $\overset{o}{A}$ (If energy is in eV)

$\Rightarrow E = \frac{hc}{\lambda}$

$\Rightarrow E = ?, \lambda = m$

$\Rightarrow 6.626 \times 10^{-34} \times 3 \times 10^{8}$ m/s

$\Rightarrow 2 \times 10^{-25}$

Q. Two radiations having energy 50 & 75 eV. What is the relation between their wavelength.

$E_1 = 50\,ev \quad E_2 = 75\,ev$

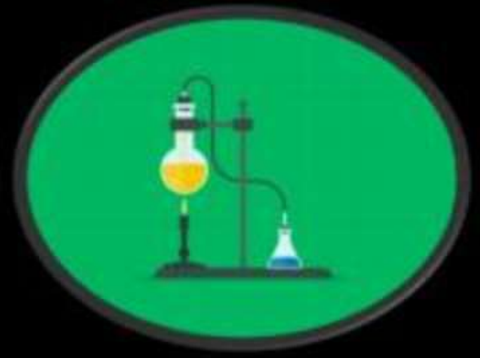
$\lambda_1 = \qquad \lambda_2$

$E = \frac{hc}{\lambda}$

$E \propto \frac{1}{\lambda}$

$$\Rightarrow \frac{E_1}{E_2} = \frac{\lambda_2}{\lambda_1} \Rightarrow \frac{\cancel{50}^{\,2}}{\cancel{75}_{\,3}} = \frac{\lambda_2}{\lambda_1}$$

$$\Rightarrow \boxed{2\lambda_1 = 3\lambda_2}$$



Q. How many photons of a green light corresponding 4000 $\mathring{A}$ wavelength will produce 8J of energy?

$n = ?$

$\lambda = 4000\ \mathring{A}$

$E = 8\ J$

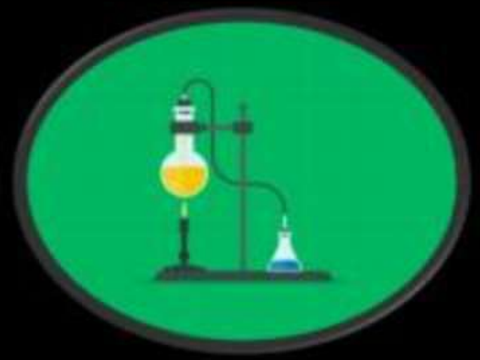
$E = \frac{nhc}{\lambda}$

$\Rightarrow 8 = \frac{n \times 2 \times 10^{-25}}{4000 \times 10^{-10}\ m}$

$\Rightarrow n = \frac{8 \times 4000 \times 10^{-10}}{2 \times 10^{-25}}$

$\Rightarrow 1.6 \times 10^{19}$ Photons

$E = \frac{nhc}{\lambda}$

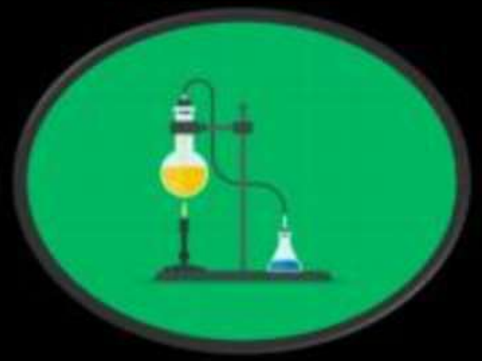


Q. Given $\lambda = 40$ nm. Find E, ν, $\bar{v}$?

$$\Rightarrow E = \frac{hc}{\lambda} \Rightarrow \frac{2 \times 10^{-25}}{40 \times 10^{-9}} \Rightarrow \quad J$$

$$\Rightarrow \nu = \frac{c}{\lambda} \Rightarrow \frac{3 \times 10^{8} \text{ m/s}}{40 \times 10^{-9} \text{ m}} \Rightarrow \quad s^{-1}$$

$$\Rightarrow \bar{v} = \frac{1}{\lambda} = \frac{1}{40 \times 10^{-9}} \Rightarrow \quad m^{-1}$$



Q. $\lambda = 4000\ A°$. Find energy in eV ?

$$E = \frac{hc}{\lambda} \Rightarrow \frac{12400}{4000}$$

$$\Rightarrow 3.1\ eV$$

thanks
for watching