JEE MAIN

MODERN PHYSICS – PART 3

FORMULAE

DUAL NATURE OF LIGHT

Now that's how you REVISE

-Mohit Goenka, IIT Kharagpur

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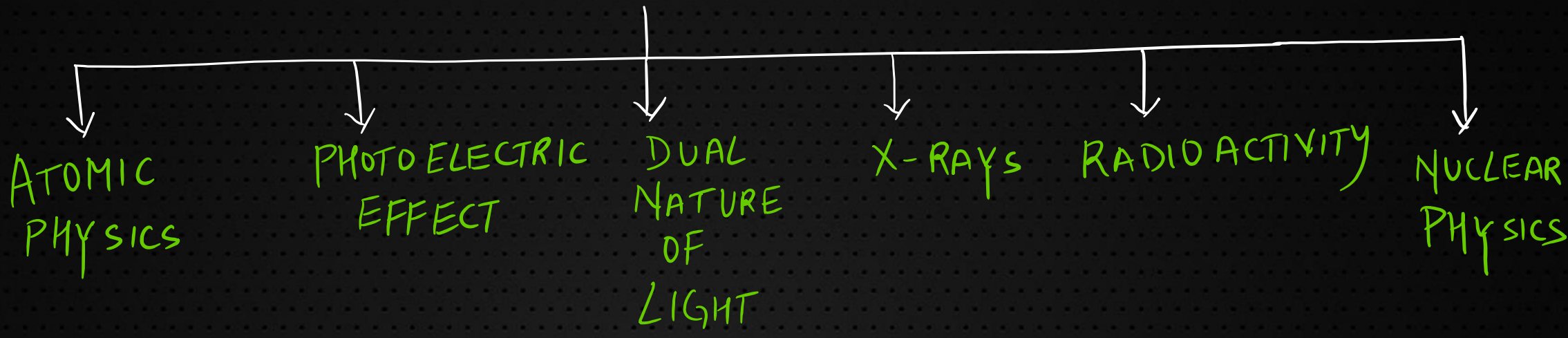
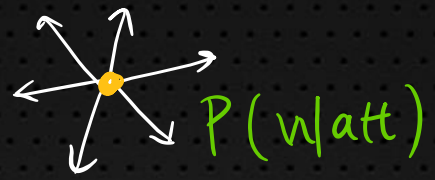
MODERN PHYSICS



PART 3

1. PHOTON FLUX / PHOTON DENSITY

↳ Number of photons emitted /sec, $N = \frac{P}{hc/\lambda} = \boxed{\frac{P\lambda}{hc}}$



↳ PHOTON FLUX, ϕ_P (no of photons per sec per unit Area)

$$\phi_P = \frac{N}{A} = \frac{1}{A} \times \frac{P\lambda}{hc} = \boxed{\frac{I\lambda}{hc}}$$

↳ PHOTON DENSITY, $\rho_N = \frac{\phi_P}{c} = \boxed{\frac{I\lambda}{hc^2}}$ { Just put I to get ρ_N

Ex: P .- - - - γ - - - - POINT SOURCE

$I = \frac{P}{4\pi r^2}$

2. WAVE PARTICLE DUALITY

PARTICLE NATURE

(a) Treated as photon

(b) Energy, $E = pc$

momentum

WAVE NATURE

Treated as Em waves

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

$$\therefore pc = \frac{hc}{\lambda}$$

$$\Rightarrow \boxed{p = \frac{h}{\lambda}}$$

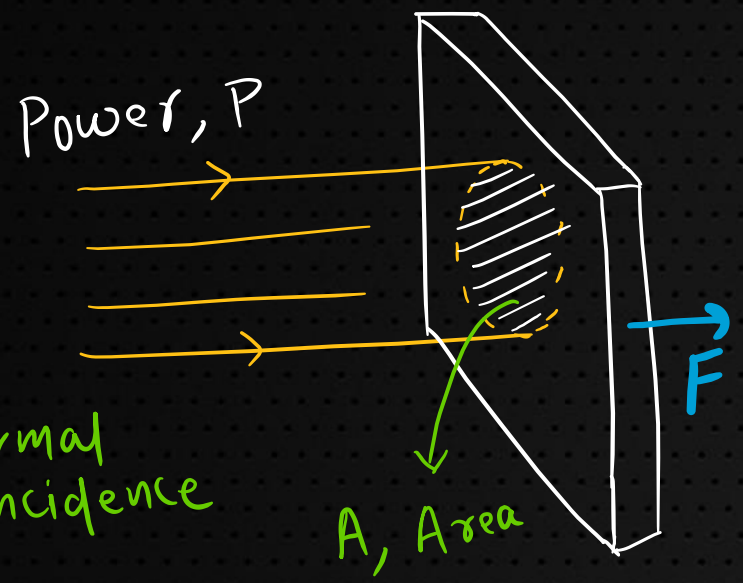
↳ photon momentum

3. DE BROGLIE'S HYPOTHESIS

(If Light behaves as particle then Physical particle too can behave as waves)

$$\lambda = \frac{h}{p} \quad \text{or} \quad \boxed{\lambda = \frac{h}{mv}}$$

4. RADIATION FORCE / PRESSURE



(a) Mostly body is black body (absorbs all light)

(b) Momentum is tranferred to body

(c) Thus body experiences FORCE (RADIATION FORCE)

F = no of photons/sec x momentum change

$$= \frac{P\lambda}{hc} \times \frac{h}{d} = \boxed{\frac{P}{c}}$$

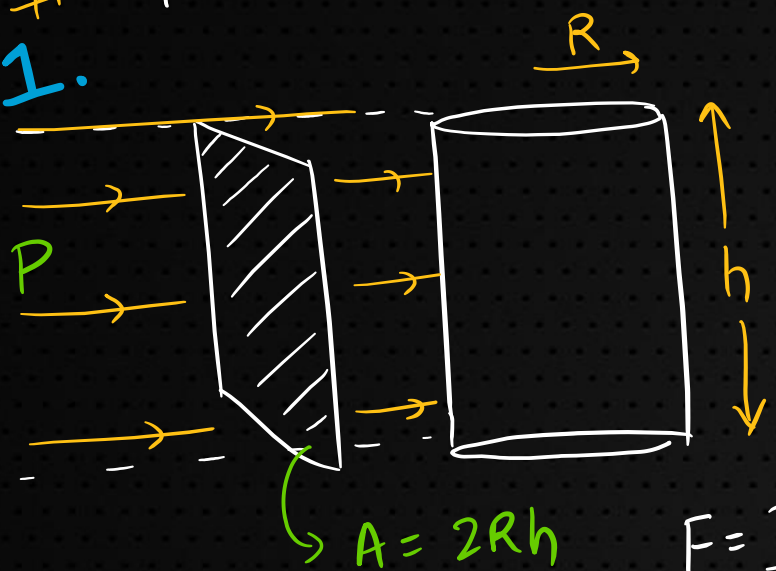
{ P: Power
P = IA

Radiation Pressure $= \frac{F}{A} = \frac{P/c}{A} = \boxed{\frac{I}{c}}$

NOTE: If surface is perfectly reflective, $F = \frac{2P}{c}$, Pressure $= 2I/c$

PROJECTED AREA

1.

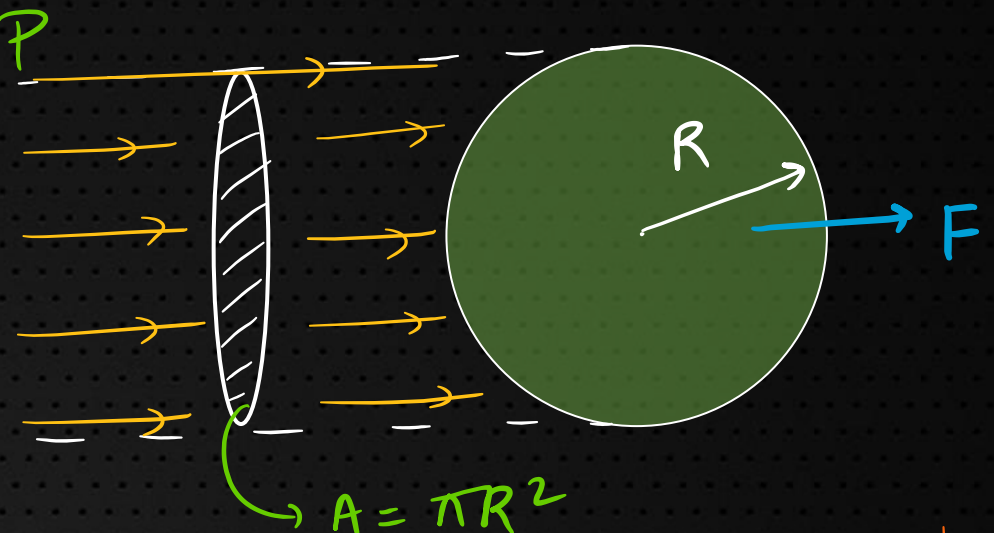


Power

$$F = \frac{P}{C} = \frac{I\,2Rh}{C}$$

(Assuming Black Body)

2.



$$F = \frac{P}{C} = \frac{I\pi R^2}{C}$$

{ Black Body

5. ATOM RECOIL DURING DE-EXCITATION

$$\lambda = \frac{12340\ A^{\circ}}{\Delta E\ (\text{in eV})}$$

Hydrogen type atom ($1e^-$ system)

$$\therefore\ mV_{recoil} = \frac{h}{\lambda}$$

$$\Rightarrow \boxed{V_{recoil} = \frac{h}{\lambda m}}$$

↳ m : mass of atom
λ : wavelength of Photon
h : Planck's Constant