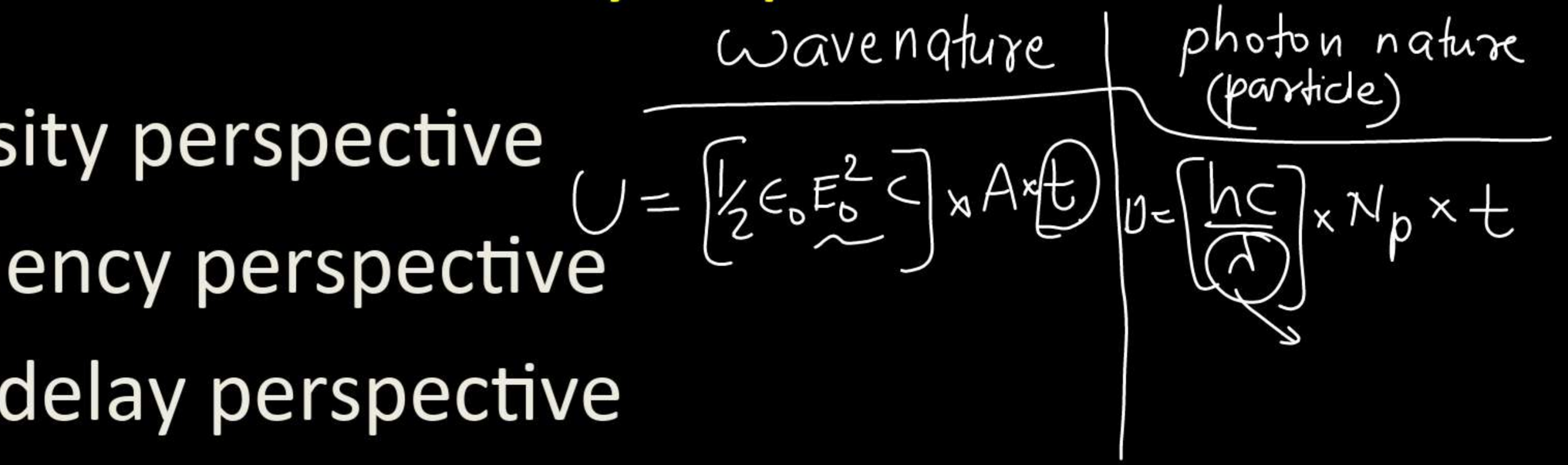
Did Photon theory explain PEE

- Intensity perspective
- Frequency perspective
- Time delay perspective



Sunday Exam questions

If $\vec{E}$ is an electric field and $\vec{B}$ is the magnetic induc-tion, then the energy flow per unit area per unit time in an electromagnetic field is given by

(a) $\frac{1}{\mu_0}\left(\vec{E} \times \vec{B}\right)$

(b) $\vec{E} \cdot \vec{B}$

(c) $E^2 + B^2$

(d) E/B

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$\vec{E}(x,t) = E_0 \sin(\omega t - kx)\hat{j}$

$\vec{B}(x,t) = B_0 \sin(\omega t - kx)\hat{j}$

$\text{Expr} = (\vec{E} \times \vec{B})$

$= E_0 B_0 \sin^2(\omega t - kx)\hat{k}$

$= \frac{1}{2} E_0 B_0 [1 - \cos 2(\omega t - kx)]$

$= \frac{1}{2} E_0^2 c$ [— II —]

$c = E_0/B_0 = \frac{1}{\mu_0 \epsilon_0}$

$c^2 = \frac{1}{\mu_0 \epsilon_0} \Rightarrow \mu_0 c = \frac{1}{\epsilon_0 c}$

$\text{Expr} = \mu_0 \frac{E_0^2}{2\mu_0 c}$ [— II —]

$= \mu_0 \left[\frac{1}{2}\epsilon_0 E_0^2 c\right]$ [— II —]

Sunday Exam questions

If v_g, v_x and v_m are the speeds of gamma rays, X-rays and microwaves respectively in vacuum then

(a) $v_g > v_x > v_m$

(b) $v_g < v_x < v_m$

(c) $v_g > v_x < v_m$

(d) $v_g = v_x = v_m$

Sunday Exam questions

A point source of electromagnetic radiation has an average power output of 800 W. The maximum value of electric field at a distance of 4.0 m from the source is:

(a) 64.7 V/m (b) 57.8 V/m

(c) 56.72 V/m (d) 54.77 V/m

$P = 800\ W\ (J/s)$

$I_{@4m} = \frac{800}{4\pi(4)^2} = \frac{1}{2}\epsilon_0 E_0^2 c$

$c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$

$c^2 = \frac{1}{\mu_0 \epsilon_0}$

$\epsilon_0 = \frac{1}{c^2 \mu_0}$

$\frac{800}{4\pi \times 16} = \frac{1}{2} \times \frac{1}{c^2 \mu_0} \times E_0^2 c$

$\Rightarrow E_0 = \sqrt{\frac{2 \times 800 \times 4\pi \times 10^{-7} \times 3 \times 10^8}{4\pi \times 16}}$

Sunday Exam questions

The work functions of Silver and Sodium are 4.6 and 2.3 eV, respectively. The ratio of the slope of the stopping potential versus frequency plot for Silver to that of Sodium is:

A). 2 B). ½

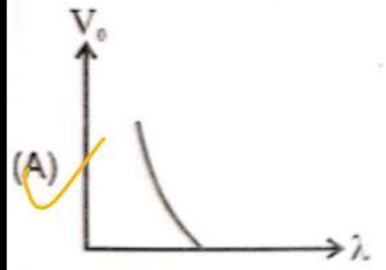
C). 1 D). 3/2

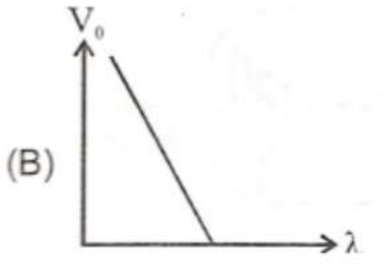
$eV_s = h\nu - \phi$

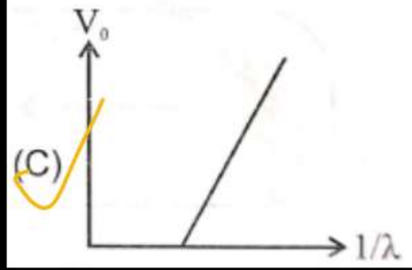
$V_s = \left(\frac{h}{e}\right)\nu - \left(\frac{\phi}{e}\right)$

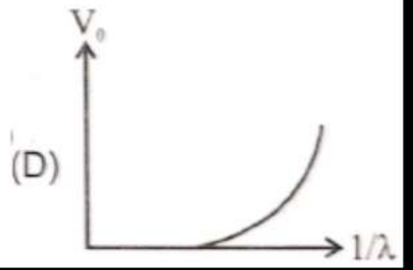
Sunday Exam questions

For photo-electric effect with incident photon wavelength λ, the stopping potential is V_0. Identify the correct variation(s) of V_0 with λ and $1/\lambda$.









Sunday Exam questions

A photoelectric emission occurs when a monochromatic light of frequency ν strikes a metal surface with threshold frequency ν_0. It is desired to increase the maximum velocity of emitting electrons by 4 times or more. What should be the frequency, ν' of the light now?

A). $\nu' \geq 16\,\nu - 15\,\nu_0$ B). $\nu' \geq 15\,\nu - 16\,\nu_0$

C). $\nu' \leq 16\,\nu - 15\,\nu_0$ D). $\nu' > \nu - \nu_0$

$K_m = h\nu - h\nu_0$

$16K_m = h\nu' - h\nu_0$

$16 = \frac{h(\nu' - \nu_0)}{h(\nu - \nu_0)}$

$16\nu - 16\nu_0 = \nu' - \nu_0$

$\Rightarrow \boxed{\nu' \geq 16\nu - 15\nu_0}$

Sunday Exam questions

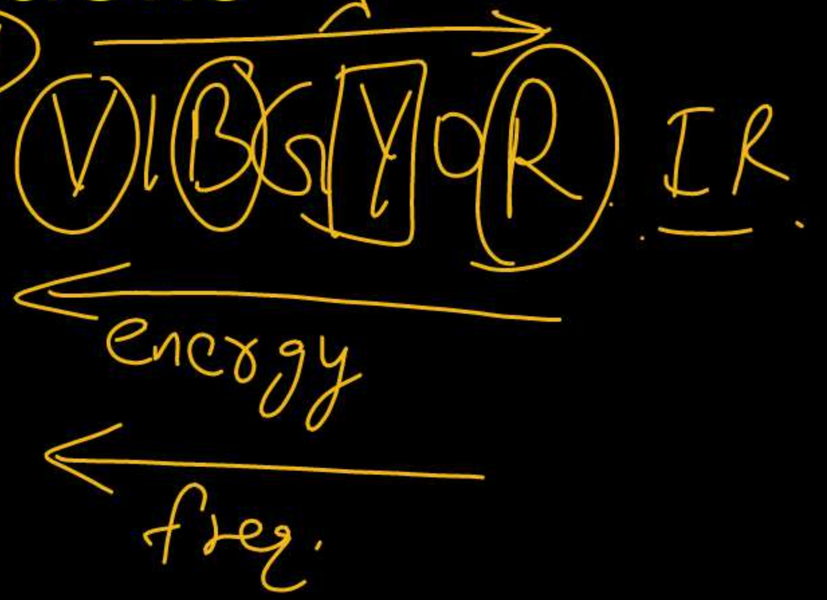
Which of the following could initiate the photoelectric emission for a particular metal, for which photoelectric effect isn't observed for yellow light of intensity I0.

A). Increase I0

B). Increase the surface area of the metal

C). Try red light

D). Try blue light



Sunday Exam questions

In a photoelectric experiment, by how much amount should the frequency of incident light be increased to cause same maximum kinetic energy of photoelectrons after the threshold frequency v0 was increased by a factor of 3

A). 2v0

B). 3v0

C). 2/3v0

D). 3/2v0

$K_m = h\nu - h\nu_0$

$K_m = h\nu' - 3h\nu_0$

$h\nu' - h\nu - 2h\nu_0 = 0$

$\Rightarrow (\nu' - \nu) = 2\nu_0$

$k_2 - k_1 = \frac{2k_2}{3} + \frac{2\phi}{3}$

$k_2/3 = k_1 + 2\phi/3$

$k_1 = k_2/3 - 2\phi/3$

Sunday Exam questions

If K_1 and K_2 are the maximum kinetic energies of pho- toelectrons emitted when lights of wavelength λ_1 and λ_2 respectively incident on a metallic surface and $\lambda_1 = 3\lambda_2$, then

(a) $K_1 > \frac{K_2}{3}$

(b) $K_1 < \frac{K_2}{3}$

(c) $K_1 = 3K_2$

(d) $K_2 = 3K_1$

$k_1 = \frac{hc}{\lambda_1} - \phi$

$k_2 = \frac{hc}{\lambda_2} - \phi$

$k_1 - k_2 = \frac{hc}{3\lambda_2} - \frac{3hc}{3\lambda_2}$

$k_2 - k_1 = \frac{2hc}{3\lambda_2}$

$= \frac{2}{3}(k_2 + \phi)$

Sunday Exam questions

Light of wavelength 0.6 μm from a sodium lamp falls on a photocell and causes the emission of photoelec- trons for which the stopping potential is 0.5 volt. With light of wavelength 0.40 μm from a mercury vapour lamp the stopping potential is 1.5 volt; then the work function in electron volts of the photocell surface is

(a) 0.75 eV (b) 1.5 eV

(c) 3 eV (d) 2.5 eV

$0.5\,eV = \frac{12400}{0.6\times10^{4}} - \phi$

$1.5\,eV = \frac{12400}{0.4\times10^{4}} - \phi$

$\phi = 1.5\,eV$

$\lambda = 0.6\,\mu m$

$= 0.6\times\frac{10^{-6}\,m\times10^{-4}}{10^{-4}}$

$= 0.6\times10^{4}\,\mathring{A}$

Radiation Pressure

(5) As $I_\lambda \uparrow$ $N_p \uparrow$.

- No of photons per sec (N_p) $\longleftrightarrow$ Power (P)
- Photon flux (ϕ_p) $\longleftrightarrow$ Intensity (I)
- Photon density (ρ_p) $\longleftrightarrow$ Energy density (E)
- Momentum of a photon = h/λ

photon properties.

(1) $c = 3 \times 10^8$

(2) m @ rest not defined

(3) $E = h\nu/\lambda$, $p = h/\lambda$

(4) Conservation.

(E & p) → Conserved

N_p → not —11—

in a Collision.