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- . 8+ YEARS OF TEACHING EXPERIENCE
- . RESEARCH WORK WITH HC VERMA SIR AT IIT KANPUR
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H.C. Verma Physics

Questions for Short Answers

C-42 Photoelectric effect
and wave particle duality

By PRATEEK JAIN SIR





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Q) Can we find the mass of a photon by the definition $p=mv$?

Only for massive particles

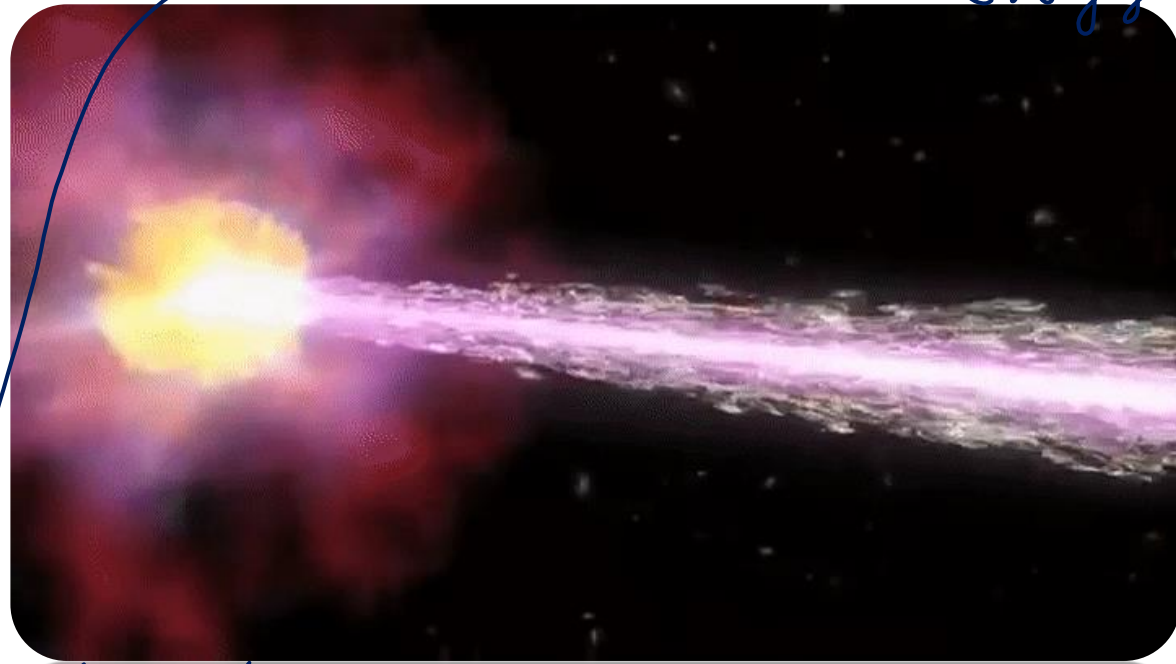
$$p = \frac{h}{\lambda}$$

photon
 $\downarrow m_0 = 0$
 $h\nu = E = pc$

$m \rightarrow \frac{E}{c^2}$

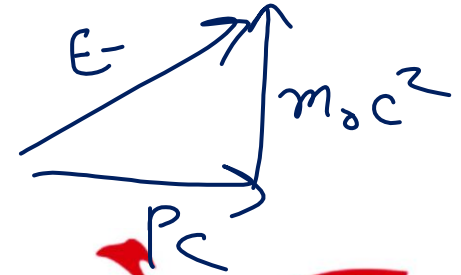
$$E^2 = (pc)^2 + (m_0c^2)^2$$

Energy



$$h\nu = pc$$

$$p = h/\lambda$$



Q) Is it always true that for two sources of equal intensity, the number of photons emitted in a given time are equal?

No

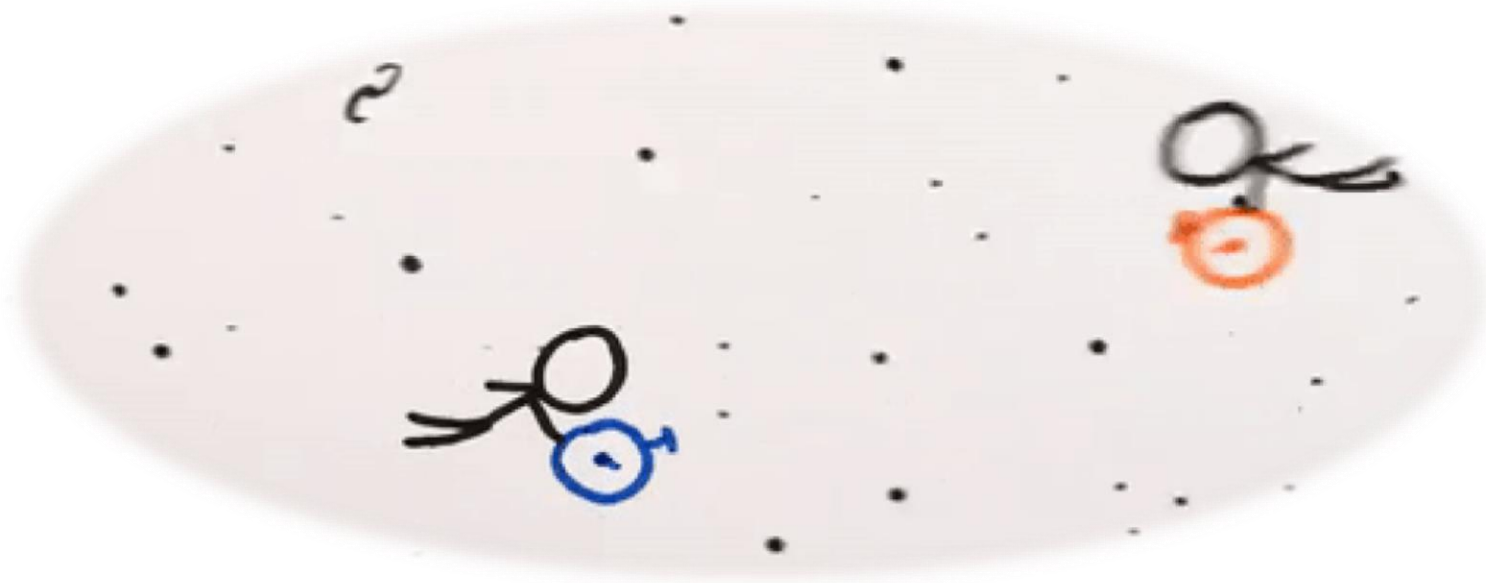


Source -1

$$\underline{I} = \frac{\epsilon}{At} = \frac{N h \nu}{tA} = \left(\frac{N}{tA} \right) (h\nu)$$



Q) What is the speed of a photon with respect to another photon if (a) the two photons are going in the same direction and (b) they are going in opposite directions?

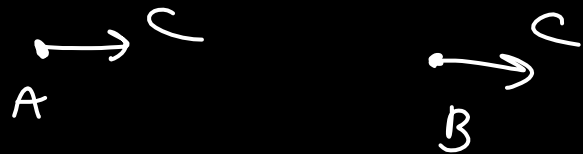


Relativistic:-



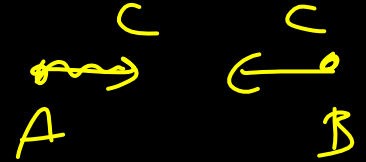
$$V_{AB} = \frac{V_A - V_B}{1 - \frac{V_A V_B}{c^2}}$$

(a)



$$V_{AB} = \frac{c - c}{1 - \frac{c \cdot c}{c^2}} = \frac{0}{0} \rightarrow \text{N.D.}$$

(b)



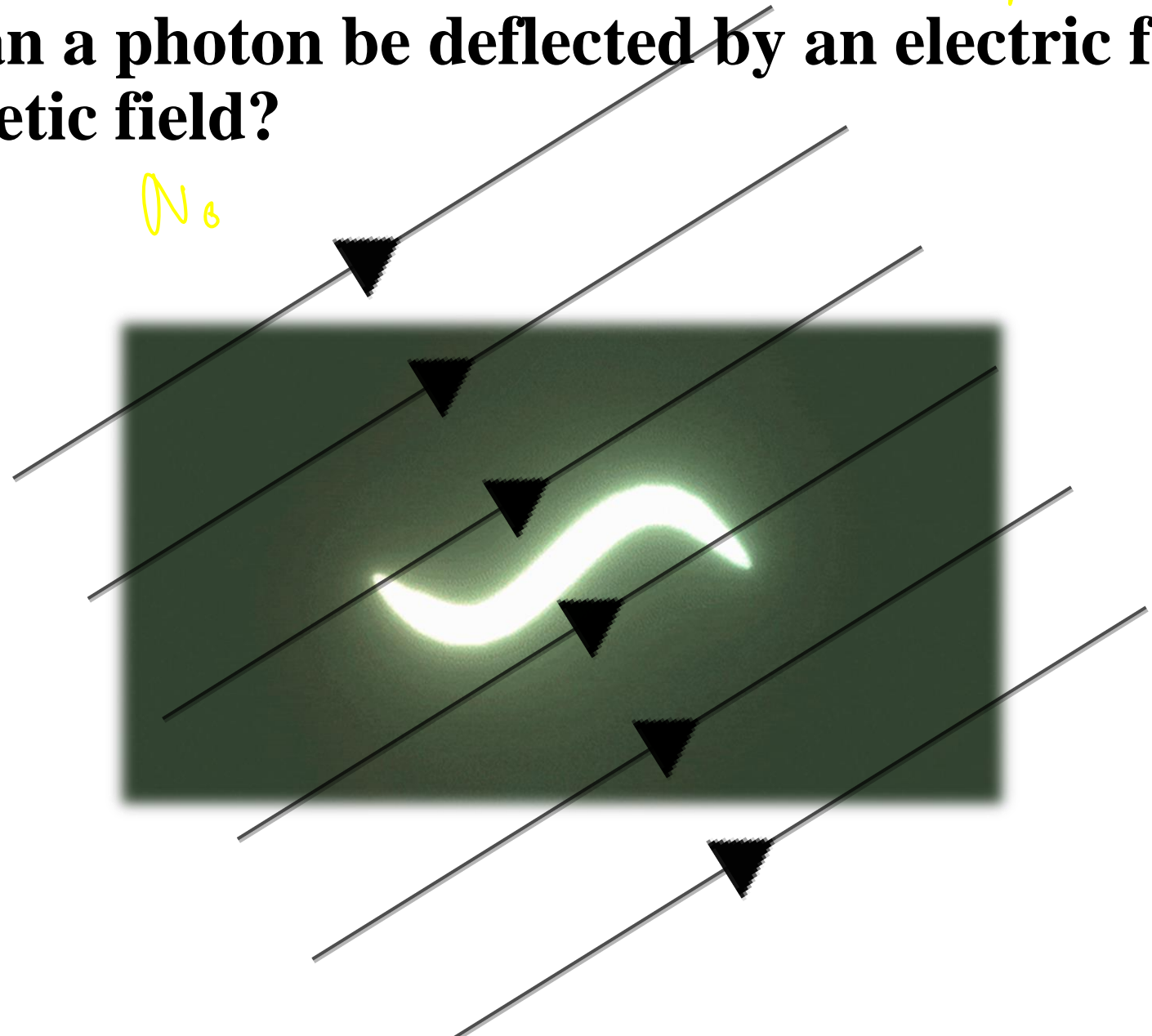
$$V_A = c, V_B = -c$$

$$\begin{aligned} V_{AB} &= \frac{c - (-c)}{1 - \frac{(c)(-c)}{c^2}} \\ &= \frac{c + c}{1 + \frac{c^2}{c^2}} = \frac{2c}{2} \\ &= c \end{aligned}$$

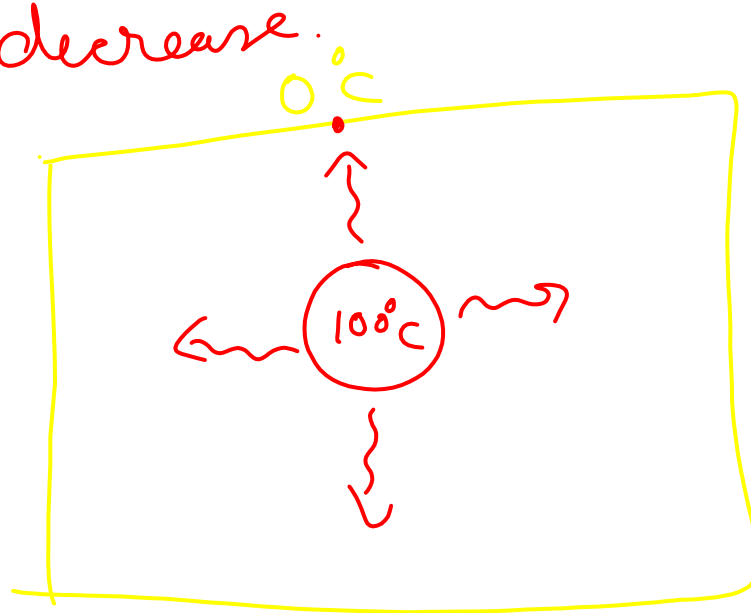
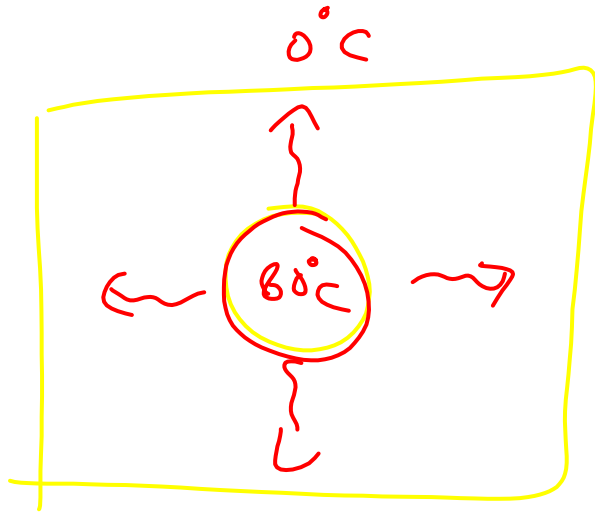
No

Q) Can a photon be deflected by an electric field? By a magnetic field?

No



Q) A hot body is placed in a closed room maintained at a lower temperature. Is the number of photons in the room increasing? *No decrease.*

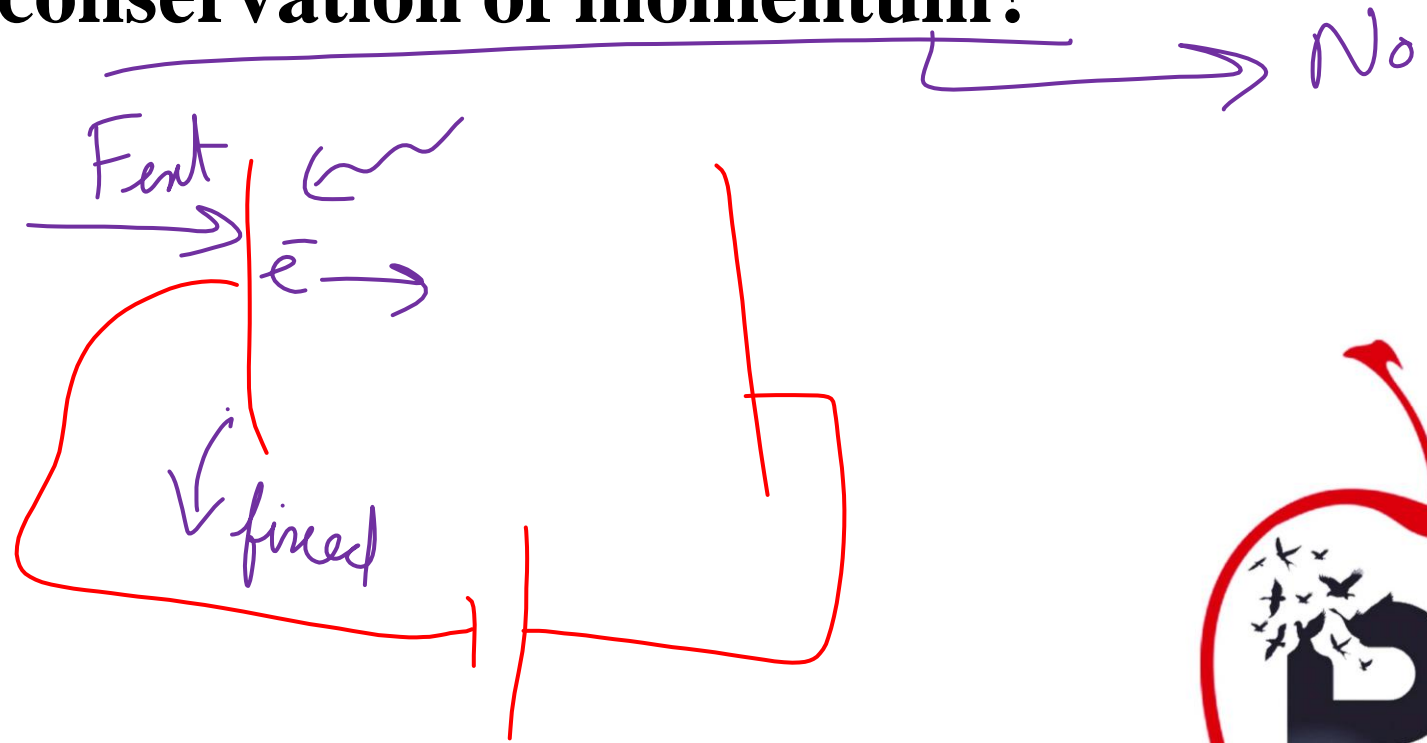


Q) Should the energy of a photon be called its kinetic energy or its internal energy?

$$E^2 = (pc)^2 + \cancel{(m_0 c^2)^2}$$

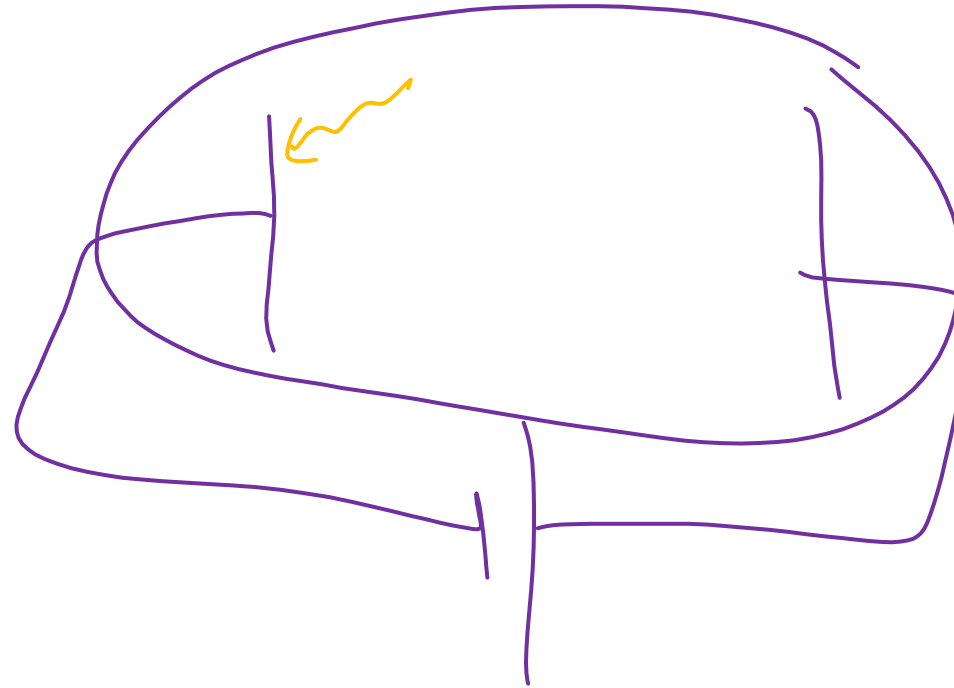


Q) In an experiment on photoelectric effect, a photon is incident on electron from one direction and the photoelectrons is emitted almost in the opposite direction. Does this violate conservation of momentum?

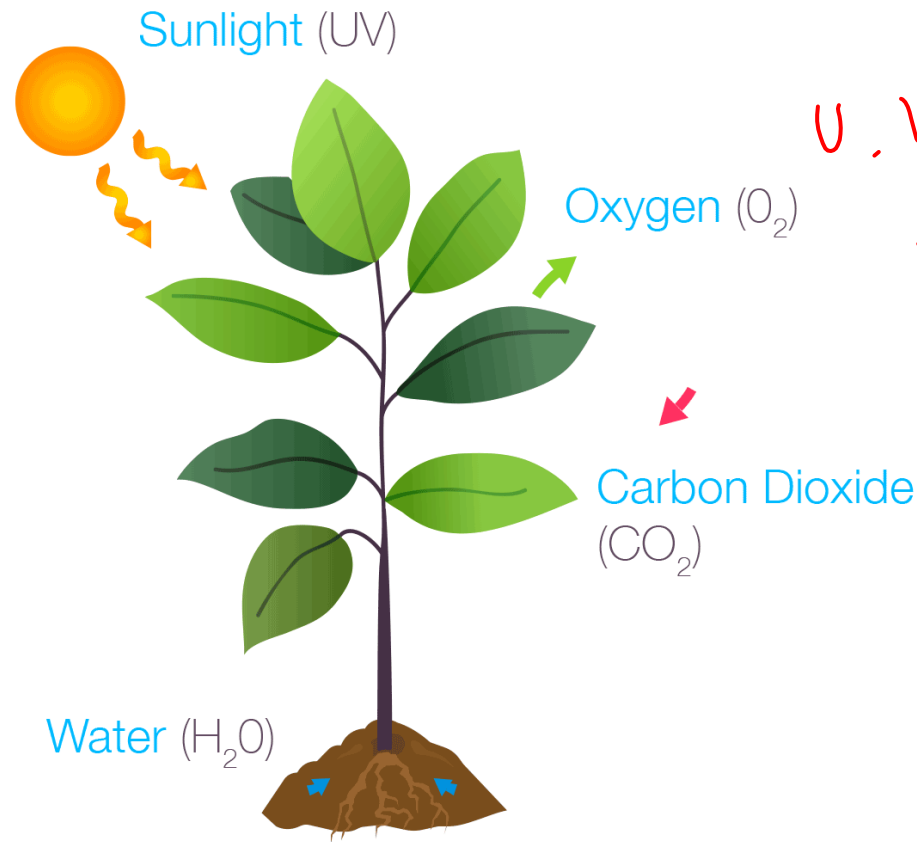


Q) It is found that yellow light does not eject photoelectrons from a metal. Is it advisable to try with orange light? With green light?

ν I B G Y O R
←
 $\nu \uparrow$ $E \uparrow$



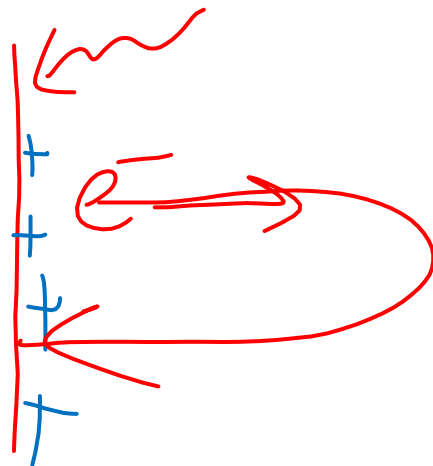
Q) It is found that photosynthesis starts in certain plants when exposed to the sunlight but it does not start if the plant is exposed only to infrared light. Explain.



U.V VIBRYOR I-R.
E ↑



Q) The threshold wavelength of a metal is λ_0 . Light of wavelength slightly less than λ_0 is incident on an insulated plate made of this metal. It is found that photoelectrons are emitted for sometime and after that the emission stops. Explain.



$\lambda < \lambda_0$
↑ more energy



Q) Is $p = \frac{E}{c}$ valid for electrons?

No

$$m_0 \neq 0$$

$$E \neq pc$$

$$E^2 = (pc)^2 + (m_0 c^2)^2$$



Q) Consider the de Broglie wavelength of an electron and a proton. Which wavelength is smaller if the two particles have (a) the same speed (b) the same momentum (c) the same energy?

$m_p \approx 2000 m_e$

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

(b) $\lambda = \frac{h}{p}$

$\lambda \rightarrow$ same.

$\lambda_p = \lambda_e$

(a) $\lambda = \frac{h}{mv} \propto \frac{1}{m}$

$m_p > m_e$

$\lambda_p < \lambda_e$

(c) $\lambda = \frac{h}{p}$

$\lambda = \frac{h}{\sqrt{2Km}} \propto \frac{1}{\sqrt{m}}$

$\lambda_p < \lambda_e$



Q) If an electron has a wavelength, does it also have a colour?

No

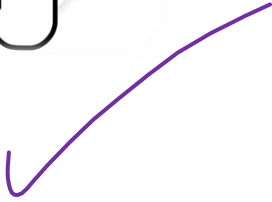
↓
β → γ rays.

$$\lambda_{e^-} = \frac{h}{p} = \frac{h}{m_e v}$$

λ → (400nm to 700nm)

$$\lambda_e \ll \ll 400\text{nm}$$





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Chalo Niklo