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PH2201, Assignment-2

Q1) Compute the peak Electric due to a light beam
E2) generated by a 5W LED bulb, passing through a sq. of side 10 cm.

A Flux = $\frac{\text{Power}}{\text{Area}} = \frac{1}{2} c \epsilon_0 E_0^2$

$\Rightarrow \frac{5}{(0.1)^2} = \frac{1}{2} c \epsilon_0 E_0^2$

$\Rightarrow \frac{1000}{c\epsilon_0} = E_0^2$

$\rightarrow E_0 = \sqrt{\frac{1000}{c\epsilon_0}}$

$c = 3 \times 10^8$ m/s
$\epsilon_0 = 8.854 \times 10^{-12}$ SI unit

$= \sqrt{\frac{10^3 \times 10^4}{8.854 \times 10^{-12} \times 3 \times 10^8}}$

$= \boxed{613}$ V/m

Q2) In the two configurations of E1 & E2 which one has stronger peak electric field.

A The LED bulb (E2) has stronger Electric Peak. ($\lambda = 650$ nm)

QB) If LED bulb, power = 5W LED bulb, passing through a sq. of side = 10cm
(E2) what is the electric field due to a single light quanta passing per sec?

A Total flux due to bulb = f_b.
" " " single photon = f_{ph}. (per second)

To Find f_{ph}.

From Planck's Formula.

$f_b = n h\nu = \frac{nhc}{\lambda}$

$A = (0.1)^2 m^2$
$P = 5W$ | $f_b = \frac{P}{A}$.

$\Rightarrow nA = \frac{f_b \cdot A \lambda}{hc}$ → No. of light quanta passing per second through the square.

So, per

$$\therefore f_{photon}\,(s^{-1}) = \frac{f_b}{\text{light quanta}} \qquad \frac{f_b}{nA}$$

$$= \frac{f_b \cdot hc}{f_b A \lambda} = \frac{hc}{A\lambda}$$

Now from Maxwell's Eqn we have,

$$\frac{1}{2} \epsilon_0 E_{0,ph}^2 = f_{photon}\,(s^{-1})$$

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

$$\therefore E_{0,ph} = \sqrt{\frac{2h}{A\lambda\epsilon_0}} = \sqrt{\frac{2 \times 6.62 \times 10^{-34} \times 10^{-11}}{10^{-12} \times 650 \times 10^{-9} \times 8.854 \times 10^{-12}}}$$

$$\approx 1.51 \times 10^{-7}$$

$$\approx \boxed{151\ nV/m}$$

Electric field per quanta of light.