$$\Delta E = h\nu = \frac{Nhc}{\lambda}$$

Where, 'c' is the velocity of light
λ is the wave length
h = plank's constant = 6.626×10^{-34} J sec.

The energy absorbed per mole of the reacting substance is called one Einstein.

* Quantum Efficiency or Quantum yield

The quantum yield (ϕ) of a photochemical process is defined as:

$$\phi = \frac{\text{Number of molecules that react}}{\text{Number of quanta of radiation absorbed}}$$

or

$$\phi = \frac{\text{Number of moles that react}}{\text{Number of Einstein of radiation absorbed}}$$

Similarly,

$$\phi = \frac{\text{Number of molecules of product formed}}{\text{Number of quanta of radiation absorbed}}$$

or

$$\phi = \frac{\text{Number of moles of product formed}}{\text{Number of Einstein of radiation absorbed}}$$

or

$$\phi = \frac{\text{Rate of Process}}{\text{Intensity of light absorbed}} = \frac{r}{I_{abs}}$$

8. Calculate the number of moles of $HCl(g)$ produced by the absorption of one joule of radiant energy of wavelength 480 nm in the reaction —

$$H_2(g) + Cl_2(g) \longrightarrow 2HCl(g).$$

If the quantum yield of the photochemical reaction is 1.0×10^6.

Sol'n The Energy of einstein associated with radiation is —

$$E = \frac{N_A hc}{\lambda} = \frac{(6.022 \times 10^{23}\ mol^{-1})(6.626 \times 10^{-34}\ J\,s)(3 \times 10^8\ m\,s^{-1})}{480 \times 10^{-9}\ m}$$

$$= \frac{(6.022 \times 6.626 \times 3) \times 10^{31} \times 10^{-34}}{480 \times 10^{-9}}\ J\ mol^{-1}.$$

$$= \frac{119.70 \times 10^{-3}\ J\ mol^{-1}}{480 \times 10^{-9}}$$

$$= \frac{119.70}{480} \times 10^{-3} \times 10^{9}\ J\ mol^{-1}.$$

$$= \frac{119.70}{480} \times 10^{6}\ J\ mol^{-1}.$$

$$= \frac{1197}{480} \times 10^{5}\ J\ mol^{-1}.$$

$$E = 2.49 \times 10^5\ J\ mol^{-1}.$$

Number of einstein corresponding to 1 J of radiant energy absorbed $= \frac{1\ J}{2.49 \times 10^5\ J} = 0.40 \times 10^{-5}$

Given, $\phi = 1 \times 10^6$

$\therefore$ No. of moles of $HCl(g)$ produced $= 1 \times 10^6 \times 0.40 \times 10^{-5}$

$= 4.0$ Ans.