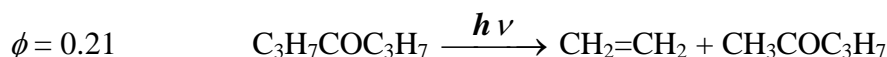


### Problem 3-08 Quantum yield of a photochemical reaction

Quantum yield of the ethylene formation from dipropyl ketone due to the light of wavelength of 313.5 nm was found to be  $\phi = 0.21$ . What is number of molecules and what is number of moles of ethylene per second will arise during irradiation by a lamp which has a power of 50 W in the spectral region of interest? Assume that the sample absorbs all incident light.

$$[ N_{\text{ethylene}} = 1.656 \cdot 10^{19} \text{ molecules s}^{-1} , n_{\text{ethylene}} = 2.75 \cdot 10^{-5} \text{ mol s}^{-1} ]$$

Solution:



$$\lambda = 313.5 \text{ nm} = 3.135 \cdot 10^{-7} \text{ m}$$

$$\left. \begin{array}{l} P = 50 \text{ W} = 50 \text{ J s}^{-1} \\ \tau = 1 \text{ s} \end{array} \right\} E = 50 \text{ J}$$

$$c = 3 \cdot 10^8 \text{ m s}^{-1}$$

$$\varepsilon = h \cdot \nu = h \cdot \frac{c}{\lambda}$$

$$\text{Number of light quanta: } N_{\varepsilon} = \frac{E}{\varepsilon} = \frac{50}{6.625 \cdot 10^{-34} \cdot \frac{3 \cdot 10^8}{3.13 \cdot 10^{-7}}} = 7.8868 \cdot 10^{19}$$

$$\phi = \frac{N_{\text{ethylene}}}{N_{\varepsilon}}$$

Number of formed ethylene molecules = number of decomposed dipropylketone molecules

$$N_{\text{ethylene}} = N_{\varepsilon} \cdot \phi = 7.8868 \cdot 10^{19} \cdot 0.21 = 1.65623 \text{ ethylene molecules}$$

$$n_{\text{ethylene}} = \frac{1.65623}{6.022 \cdot 10^{23}} = 2.75 \cdot 10^{-5} \text{ ethylene moles}$$