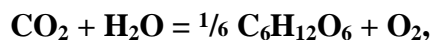


Problem 3-06 Photosynthesis

Standard reaction Gibbs energy of photosynthesis,



is $\Delta_r G^\ominus = 528 \text{ kJ mol}^{-1}$. If you can assume that all the incident energy is used for photosynthesis, estimate the number of photons of red light ($\lambda = 680 \text{ nm}$), absorbed by chlorophyll, needed to bind one molecule of carbon dioxide.

[$N_\epsilon = 3$]

Solution:

$$\lambda = 680 \text{ nm} = 6.8 \cdot 10^{-7} \text{ m}$$

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

$$\Delta_r G^\ominus = 528 \text{ kJ mol}^{-1}$$

$$\text{Energy of one light quantum: } \epsilon = h \cdot \frac{c}{\lambda} = 6.625 \cdot 10^{-34} \cdot \frac{3 \cdot 10^8}{6.8 \cdot 10^{-7}} = 2.9228 \cdot 10^{-19}$$

$$\text{Number of CO}_2 \text{ molecules: } N = \frac{\Delta_r G^\ominus}{N_A} = \frac{528000}{6.022 \cdot 10^{23}} = 8.768 \cdot 10^{-19}$$

Energy per one molecule of CO₂:

$$N_\epsilon = \frac{N}{\epsilon} = \frac{8.768 \cdot 10^{-19}}{2.9228 \cdot 10^{-19}} = 3$$