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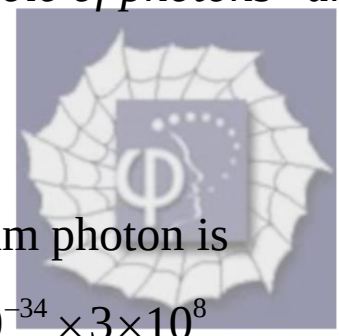
Problem 49.43 (RHK)

A satellite in earth orbit maintains a panel of solar cells at right angles to the direction of the Sun's rays. Assuming that solar radiation is monochromatic with a wavelength of 550 nm *and arrives at the rate of* 1.38 kW m^{-2}, *we have to find the area of the panel in order that* "*one mole of photons*" *arrives each minute.*



Solution:

Energy of a 550 nm photon is

$$\varepsilon = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}\times3\times10^{8}}{550\times10^{-9}} \text{ J}$$

$$= 3.62\times10^{-19} \text{ J.}$$

Intensity of the solar intensity assuming that the solar radiation is monochromatic with a wavelength of 550 nm is given to be

$I = 1.38\times10^{3}$ W m^{-2}.

Therefore, number of photons that will pass per second through 1 m^2 plane surface placed at right angles to the Sun's rays will be

$$n = \frac{1.38 \times 10^{3}}{3.62 \times 10^{-19}} = 3.81 \times 10^{21}.$$

And number of photons that will pass through $1\ \mathrm{m}^2$ per minute will be

$$n' = 3.81 \times 10^{21} \times 60 = 2.28 \times 10^{23}.$$

Therefore, the area of the panel through which 1 mol of photons will pass through per minute will be

$$A = \frac{6.2 \times 10^{23}}{2.28 \times 10^{23}}\ \mathrm{m}^2 = 2.72\ \mathrm{m}^2.$$