Marks
4

- Direct damage to the DNA of skin cells can be brought about by exposure to ultraviolet radiation of wavelength 300 nm. What are the frequency and energy (in kJ mol^{-1}) of this radiation?

The frequency, ν, and the wavelength, *λ* of the radiation are related by *c* = ν*λ*. Hence:

$$\nu = \frac{c}{\lambda} = \frac{2.998 \times 10^{8}\ \mathrm{m\ s^{-1}}}{300 \times 10^{-9}\ \mathrm{m}} = 1 \times 10^{15}\ \mathrm{s^{-1}} = 1 \times 10^{15}\ \mathrm{Hz}$$

The energy of the radiation is given by $E = h\nu = \frac{hc}{\lambda}$. Hence:

$$E = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34}\ \mathrm{J\ s})(2.998 \times 10^{8}\ \mathrm{m\ s^{-1}})}{(300 \times 10^{-9}\ \mathrm{nm})} = 6.62 \times 10^{-19}\ \mathrm{J}$$

This is the energy per photon. For a mole, the energy is:

$$E = (6.62 \times 10^{-19}\ \mathrm{J}) \times (6.022 \times 10^{23}\ \mathrm{mol^{-1}}) = 400000\ \mathrm{J\ mol^{-1}} = 400\ \mathrm{kJ\ mol^{-1}}$$

Frequency: **1×10^{15} Hz**	Energy: **400 kJ mol^{-1}**