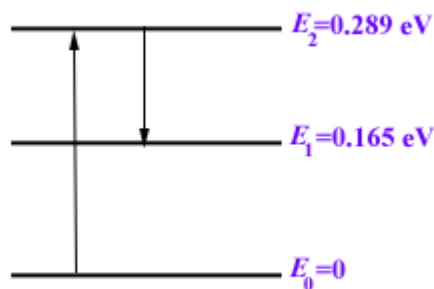


784.

Problem 41.63 (HRW)

Martian CO₂ laser. Where sunlight shines on the atmosphere of Mars, carbon dioxide molecules at an altitude of about 75 km undergo naturally occurring laser action. The energy levels involved in the action are as shown in the figure: population inversion occurs between energy levels E_2 and E_1 . (a) We have to find the wavelength of the sunlight that excites the molecules in the lasing action. (b) We have to find the wavelength of the lasing action. (c) We have to identify the region of the electromagnetic spectrum in which the excitation and the lasing wavelengths lie.



Solution:

(a)

From the figure we note that the energy of the photon that excites the carbon dioxide molecule from the level E_0 to E_2 is

$$\begin{aligned}\lambda_{excitation} &= \frac{hc}{(E_2 - E_0)} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{0.289 \times 1.6 \times 10^{-19}} \text{ m} \\ &= 43.0 \times 10^{-7} \text{ m} = 4.3 \mu\text{m}.\end{aligned}$$

(b)

The wavelength of the lasing light is

$$\begin{aligned}\lambda_{laser} &= \frac{hc}{(E_2 - E_1)} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{(0.289 - 0.165) \times 1.6 \times 10^{-19}} \text{ m} \\ &= 100.3 \times 10^{-7} \text{ m} = 10.0 \mu\text{m}.\end{aligned}$$

(c)

We note that the excitation and the lasing wavelengths lie in the infrared region of the electromagnetic spectrum.