CL42_Q1. What are the different modes of vibrations in a CO_2 molecule?

Ans:

The carbon dioxide molecule has three different modes of vibration. The energies associated with each of these vibrations are quantized in different sets.

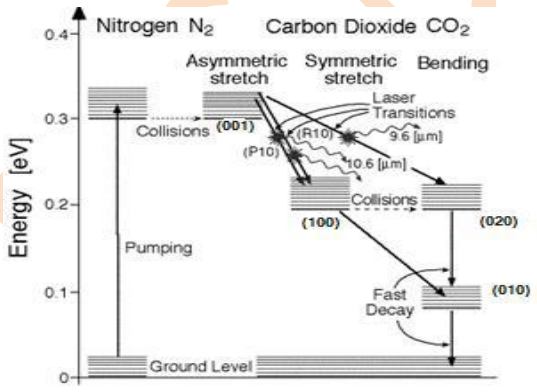
i. Symmetric stretching mode: In this mode, the oxygen atoms oscillate along the molecular axis either approaching towards or departing from the carbon atom simultaneously along the molecular axis. The molecule possesses intermediate energy in this state of vibration.

ii. Asymmetric stretching mode: In this mode of vibration all the 3 atoms oscillate along the molecular axis. But the two oxygen atoms move in one direction while the carbon atoms move in the opposite direction and vice versa. The molecule possesses highest energy in this state of vibration.

iii. Bending mode: In this mode, all the three atoms oscillate normal to the molecular axis. During the vibration, the two oxygen atoms pull together in one direction as the carbon atom is displaced in the opposite direction.

CL42_Q2. With an energy level diagram discuss how lasing action is achieved in molecular laser.

Ans:



CO_2 laser consist of mixtures of gas such as CO_2: N_2: He in the ratio of 1:2:8. On providing electrical pumping, the N_2 molecules are excited with energy close to the excited states of CO_2 which results in the excitation of CO_2 to the asymmetric

stretch mode. The asymmetric stretch states have a higher life time and higher energy than the symmetric and bending modes. An excited carbon dioxide molecule in the higher anti symmetric stretch state can relax into the symmetric stretch state giving a radiation at 10.6 µm (0.117eV) and into the bending mode with emission of IR at 9.6 µm (0.129 eV)

CL42_Q3. Mention the possible laser transitions that occur in CO_2 laser?

Answer

Carbon dioxide laser is a molecular laser which has laser emissions in the infrared region. The two possible laser transitions are of wavelength 9.6 µm and 10.6 µm.