Answer 9.7c

c) In IRMPD, how many photons from a continuous wave carbon dioxide laser of 10.6 μm wavelength do you need to increase the internal energy of an ion by about 3 eV?

Using the relationships $E_{phot} = h\nu$ and $\nu = c / \lambda$ we can obtain an equation to calculate the IR photon's energy:

$$E_{phot} = \frac{hc}{\lambda} = \frac{6.62 \times 10^{-34}\,\text{Js} \times 2.99 \times 10^{8}\,\text{ms}^{-1}}{1.06 \times 10^{-5}\,\text{m}} = 1.86 \times 10^{-20}\,\text{J}$$

The number of photons n_{phot} is then obtained from:

$$n_{phot} = \frac{E}{E_{phot}} = \frac{3 \times 1.602 \times 10^{-19}\,\text{J}}{1.86 \times 10^{-20}\,\text{J}} = 25.8$$

The ion needs to absorb 26 IR photons to increase its internal energy by 3 eV.